THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXX.—*On the Relations which exist between the Phenomena of Erratic Blocks in Northern Europe and the Elevations of Scandinavia;* by M. DESOR.*

THERE is a point in the phenomena of boulders not hitherto presented, which appears to me capable of throwing much light on the question that now engages our attention: it is the examination of the connection which subsists between the erratic blocks of Northern Europe and the elevation of Scandinavia. These relations are the more important, as they admirably explain some circumstances which are peculiar to the erratics of the north, and of which there is no example in Switzerland. These peculiarities are: 1, the occurrence of polished and grooved surfaces beneath the present level of the sea: 2, the existence of *marine shells* attached to the polished rocks at a height much above the *present* level of the sea: 3, the presence of marine shells in the midst of the diluvium even at an elevation of eight hundred feet: 4, the *osars*, or ridges of boulders and stones which contain the shells of the Baltic.

Among the phenomena which prove so fully the instability of the Scandinavian soil, there are some facts which indicate the elevation of the land, while others on the contrary attest its subsidence. Thus, we cannot have less equivocal proof of an elevation of a country, than the occurrence at a great height and at a considerable distance from the coast, of shells now inhabiting the adjacent seas, and whose perfect state of preservation leaves no doubt that they lived where they now occur: for had they

* Communicated by the author, through Prof. AGASSIZ, for this Journal. Translated from the French.

been transported by a current or any other violent agent, they would have been broken or at least much worn. But should we refuse to admit the evidence which these shells offer, we cannot deny the proof afforded by the serpulas of Christiania and the barnacles of Uddevalla, whose shells still adhere to the rocks far above the sea.

On the other hand, the fact that the striæ and furrows are continued *beneath the waters of the sea*, attests no less strongly that at a certain epoch the land must have been more elevated than now. In fact, it is a point on which the partizans of different hypotheses are nearly agreed, that the phenomena of erratics took place over a submerged country. Glaciers can advance only as far as the limits of the land: we learn from the observations of Mr. Martins, that even the glaciers of Spitzbergen do not project beneath the sea; for, as the temperature of the water is above that of the ice, it melts the glaciers by its contact, and a considerable space equal to the height of the tide, separates the glacier from the water.*

But if, as I believe I have sufficiently proved, the polished surfaces of the north have been occasioned by immense glaciers, which have transported from afar the erratic blocks of Scandinavia and furnished the materials of the diluvium and of the *osars*, it follows that the whole country which bears traces of scratches, must have been out of water when the glaciers produced this polishing and made the striæ and furrows which we now see there. If these striæ were exactly at the level of the sea, we might suppose that Scandinavia was then at the same elevation as at the present day. But we have seen numerous cases in that island in which the furrows are found *under* the sea, from which facts we must conclude according to the principles laid down, that the land at that epoch was as much above its present height as the striæ are now below the waters. These results although opposed, are not as they may at first appear, contradictory; and it is here that the observation of shells completes the study of erratic phenomena properly so called, by showing us the chronological order of these events. In fact, the barnacles of Uddevalla and the serpulas of Christiania which are found, the former at the height of two hundred, and the latter of one hundred and seventy feet above the sea, prove irresistibly that the coast has sunk in these places: the fact that these animals are adhering to striated rocks, shows not less certainly that

* In order that glaciers should advance upon the bottom of the sea, it is necessary that the temperature of the water should be below zero the year through; but such a climate would render the formation of glaciers impossible. A humid atmosphere rather than a severe temperature, is necessary to the existence of glaciers, and the former is incompatible with the temperature of a sea constantly below zero.

the rocks were dry before these animals were living there; whence I read this double conclusion: 1st, that the graving of the rocks was anterior to the epoch of the barnacles and serpulas, and 2d, that to receive these animals, the coasts of Uddevalla and Christiania must have sunk as far at least as would be equivalent to the actual height of these fossils.

But the barnacles and serpulas are not the only proofs of this subsidence. At a much greater height we find shells, over these polished and striated rocks, imbedded in the diluvium; and as the species are in general indigenous, and probably contemporaneous with the serpulas and barnacles, it follows of course that the submergence must have been considerable, and equal at least to the site of the highest shells of the diluvium, (eight hundred feet.) This submergence must consequently have taken place between the epoch of the furrowing and the stratification of the diluvium. At that time the glaciers having quitted the plain to retire to the interior mountains, the waters of the sea invaded all the low country of Scandinavia, surrounding the solid masonry of the Scandinavian mountains with an ocean to which we shall be able to fix some approximate limit when we are acquainted with the boundaries of the region of diluvial shells. In passing, I would remark, that the analogy of the erratic blocks of Finland with those of Scandinavia, allows us to believe that at that time the Gulf of Bothnia was not separated from the North Sea.

We have no means of determining the length of time which elapsed between the retiring of the glaciers, and that subsiding of the soil which led to the invasion of the sea. However, the perfect preservation of the polishing beneath the diluvium, would seem to prove that the period could not have been long. Nowhere are the grooves and scratches more distinct, than where they have been uncovered by removing the diluvium; they usually form a striking contrast with those rounded rocks whose surface has been for a long time exposed to the wearing effects of the atmosphere.* But as we have no reason to suppose that the action of the atmospheric agents was formerly less energetic than now, I am compelled to believe that the preservation of the polished surfaces under the diluvium, is owing to their having been exposed only a comparatively short time to wear from these agents. It is even probable that the invasion of the sea was one of the causes which have been active, if not decisive, in the destruction of the great glaciers. It explains at the same time the colder

* We may believe, that if after a new deluge the boulders which are at present exposed should be covered again with gravel, the geologists of future ages would have much more trouble in ascertaining the causes which have produced the effects, than we have at the present day, aided as we are by the preservation—frequently admirable—of the polishings, furrows, and fine striæ.

character of the diluvial fauna; for a mass of ice so considerable could not be melted without materially chilling the waters which bathed it. The cold having slowly disappeared, the temperature would have been gradually elevated, and the fauna of the waters would take by degrees the more temperate character which distinguishes it at the present day.

To this epoch of the invasion of Scandinavia by the waters of the sea, we should refer the arrangement in beds of the mud, sand, and gravel, which the great glacier has left in place in testimony of its ancient extent. The action of waves coming in upon this movable soil, has here overturned and heaped up the debris of marine life upon the shore, where the remains are found mingled with scratched rocks and pebbles. If such is really the origin of these deposits, there is no reason for surprise that the scratched pebbles should be so numerous. The waves in striking them against each other, would wear them more or less; and if blocks of a considerable size have generally better preserved their markings than the pebbles, it is because from their weight they were less exposed to being moved and rolled. It is very natural in Switzerland, where the action of the waters has been less manifest and less prolonged, that the striated pebbles should be more numerous. Thus you do not find there, or only occasionally, distinct beds in the properly glacial deposits. Those which are met with, ordinarily occur in the neighborhood of torrents.*

After this epoch of immersion, even the proximate duration of which it is impossible at present to ascertain, the country of Scandinavia was again elevated. The shores bordering the high central regions, the plains of Sweden, and those of Finland, were successively raised from the bosom of the waters, bringing back with them to the surface the same mud, the same diluvial gravel, which had been deposited by the glaciers and which had undergone no other change in the interval than that of being irregularly stratified and mingled with shells. The depressions of the soil alone remained covered with water, and formed the lakes of Sweden and Finland, as well as the Gulf of Bothnia. The last, isolated from the ocean by the elevation of the intermediate land, has lost by degrees its saltness; and this explains the character of its fauna, which is rather the fauna of brackish water than that of the sea. The interior lakes also were transformed completely into freshwater, and here and there may perhaps be found some indications of their ancient condition. It appears that certain fishes in particular have resisted these changes in the water, and according to researches of Scandinavian zoologists, especially of Mr. Esmark, the trout of Swedish lakes (*Salmo*

* Voy. Rod Blanchet, Terrain erratique alluvien du Cassin du Léman.

trutta, L.) is only a species of salmon, like the *Salmo salar*, L. But as the salmon of the coast does not ascend into the lakes, we are naturally led to the conclusion, that this fish has resisted the modifications that have occurred where it dwells. The immersion of land does not take place alike in all parts; the beautiful observations of Messrs. Keilhau and Bravais, upon the ancient marks of the level of the Scandinavian sea, teach us that there it was not uniform throughout. Finally, if it is true that the *osars*, which may be traced a long distance into the interior and whose mode of formation we have explained above, indicate successive sea shores, it follows that the Gulf of Bothnia was once much larger than at present. A large belt of coast now under cultivation, was then under water, and only gradually became elevated.

This successive retreat of the waters has taken place mostly during the present epoch, as undeniable traces of man* are found in the interior of the *osars*. It is probable that during this period of slow immersion, there lived in Scandinavia a primitive people, an entirely different race, as their osteology indicates, from that of recent Scandinavia, and whose skeletons are found in the peat beds mingled indiscriminately with those of animals, some of which have completely disappeared from the surface of the earth, such as the *Bos urus*, and others which are no longer known in the same countries, as the reindeer.†

Conclusion.—It follows from the preceding considerations, that whilst the upheavals of Scandinavia are of great importance in the study of erratic blocks, the latter furnish us in their turn with valuable hints as to the time and the geological bearing of these elevations. I have shown that the elevations are not confined to the historical epoch, but extend far back into the period of the diluvium. On the other hand we learn from the same examinations, that these elevations have not been continuous; that on the contrary they were intermitting and in sweeps, since the soil is successively raised and depressed. We have distinguished in this connection three principal points: 1st. An epoch when the land was higher than now, the epoch of the glaciers; 2d. A general sinking of the plains of Scandinavia, bringing with it an irruption of the sea; 3d. The rising of the same plains, which is even now in operation.

Each of these periods must have had a considerable duration. We can readily believe that while an agent is acting so slowly that a glacier might transport for hundreds of leagues the stones and gravel taken from the Norwegian mountains, a long time must have been required, whose minimum of years would be thousands, if the movements of glaciers in our day are regarded as a criterion.

* See Lyell, upon the proofs of a gradual elevation of the soil in certain parts of Sweden.

† I am indebted to the beautiful works of Messrs. Wilson and Eschricht for these details.

The second period must have been at least as long, if we consider the time required for the existence, propagation, and death of an entire fauna, whose numerous remains are found upon a land once submerged.

Finally, the third period comprehends the historical epoch, when the country was inhabited by the foreign race whose remains are discovered in the peat beds.

It follows therefore, that the glacier epoch is not merely an accident in the history of our globe, but that it embraces a long period, the more important to the geologist, that it is the connecting link between the antediluvial times and the historical era.

ART. XXXI.—*On the Analysis of the Oat;* by Prof. JOHN PITKIN NORTON, of Yale College.

(Continued from p. 236, this volume.)

3. *Of the Ash yielded by the Chaff.*—The chaff forms a very small and seemingly unimportant part of the plant; but it is in reality indispensable to its perfection, and a close examination shows that it is admirably adapted to its particular end.

1. The quantity of ash which it yields is greater than that left by any other part, and as in the other parts, this quantity varies with the soil and with the variety of oat.

The following table exhibits the per-centage of ash and water, in seven specimens of chaff.

TABLE XXI.

	Hopeton Oats.			Sandy Oats.	Dun Oats.	Potato Oats.		Mean of seven trials.
	No. 1.	No. 2.	No. 3.			No. 1.	No. 2.	
Per-centage of water, . . .	10·28	10·69	10·58	9·60	11·62	11·16	10·95	10·69
Do. of ash, calculated dry,	7·23	10·69	16·53	18·97	19·16	18·59	27·47	16·94

It is singular that the per-centage of water in the thin, dry, light chaff, should be fully equal to that in the straw.

The average of the above is nearly 17 per cent.; as this is higher than that of any other part, so no other exhibits so wide a range. The chaff of Potato oat, No. 2, has nearly four times as much ash as that of Hopeton oat, No. 1. This last-mentioned chaff is from the sample of oats I have noticed before, as grown on a poor mossy soil.

2. The quality of the ash from the chaff also varies greatly in different samples, and its composition suggests some interesting inquiries. As before, I will give an extended analysis first.

Composition of Ash from Chaff of Hopeton Oat, from Mr. Harbottle, Hexham, Northumberland.

TABLE XXII.

	Per-centage.
Sulphuric acid,	5·32
Chlorid of sodium, (common salt,)	5·11
Potash, Soda,	7·96
Phosphates of lime, magnesia, and iron,	5·84
Lime,	4·55
Magnesia,	1·84
Soluble silica,	11·99
Insoluble silica,	56·05
	98·66

The quantity of silica in this ash amounts to nearly 70 per cent., being much greater than in any ash that I have before instanced. There is an extraordinary quantity of soluble silica in this chaff, and it may probably in this respect be considered an extreme case, for I have not found so much in any other sample.*

The office of the chaff seems to be to protect the oat during the earlier stages of its growth. For this reason fully one-sixth of its weight is ash, and of this ash 70 per cent. is silica. While the husk is yet soft and green, the chaff has arrived nearly at maturity, and closely envelops the tender seed with its flinty covering. As the husk gradually hardens, the chaff unfolds, and at last leaves the grain entirely to this its ultimate protector.

3. It now remains to show that the chaff varies in quality as well as quantity. The above single analysis must not be considered as a standard for the composition of the ash in other samples, it only indicates its leading features. The four following analyses, on a less extended scale, will be found to present variations equally extensive with those we have noticed in the other parts of the plant.

Composition of Ash from four specimens of Chaff.

TABLE XXIII.

	Hopeton Oats.		Potato Oats,	Dun Oats,
	No. 1. Light Barley soil.	No. 2. Poor Moss.	Gravelly soil.	Good loam.
Salts soluble in water, chiefly sulphates and chlorids,	35·02	34·12	19·86	18·66
Phosphates of lime, magnesia and iron,	4·29	8·73	2·26	2·40
Lime and magnesia,	4·03	7·14	7·01	4·44
Silica,	56·65	50·01	70·86	74·50
	99·99	100·00	99·99	100·00

* I have taken many precautions in my determinations of soluble silica; in the above instance the quantity was so large, that I fused the substance obtained with carbonate of soda, and confirmed my previous result. I was at first accustomed to burn and weigh, before treating with acid, that portion of the watery solution which refused to redissolve after evaporation to dryness; but latterly, fearing that by burning, some alkaline silicates might be formed insoluble even in strong acid, I added the acid to the undissolved portion before burning.

The soluble silica, here included in the salts soluble in water, is to be added to the insoluble silica. With this addition, the silica in the last sample amounts to about 80 per cent. The Hopeton chaff, No. 2, is from the same mossy land which I have noticed in all the other parts as deficient in silica. In the chaff and leaf, however, this deficiency is not so great as in the straw; a subsequent table, No. 30, will show that the husk also has nearly its full proportion. This partiality, as it may be called, in the distribution of silica, I have noticed in several other analyses of the various parts. The leaf must have its framework to sustain it, while drawing food for the whole plant from the atmosphere; the chaff must have a large quantity of silica to form an effective covering for the tender oat; and the husk also must in its turn be fitted to protect the grain through all vicissitudes, until it is committed to the earth, and has commenced its growth. We find it actually the fact, that these parts are better supplied than the stalk, a part which can better perform its functions with a small supply, than any other. Are we not then justified in supposing that some law exists by which those parts, where a particular substance is most needed, are supplied, even to the deprivation of other parts which can *exist* with a smaller quantity? Nature thus does all in her power towards the complete performance of her duties. She labors to perfect the leaf, the chaff, the husk, and through them finally the seed, upon which the future continuance of the species depends; if now the materials are exhausted, the straw must be weak and imperfect. *Nature* can do no more, the necessary substances are not within her reach, or she is prevented from obtaining them by the physical condition of the soil; the responsibility is thrown upon the cultivator, who has neglected his duty in the preparation of the soil, or in furnishing those substances which are essential to its fertility.

4 and 5. *Of the Ash yielded by the Husk and the Grain.*— In the consideration of the *quantity* of the inorganic constituents of the husk and of the grain, I shall separate them as I have done the other parts of the plant. In the first place, however, I shall draw attention to some points in which comparisons of the two parts are involved.

1. I have thought it of some importance to ascertain the relative proportions of husk and grain in different samples of oats, with the view of determining whether this might be an index of quality.

The following table gives these proportions in nine samples of oats.

TABLE XXIV.

	Hopeton Oats.				Potato Oats.	Dun Oats.	Victoria Oats.	Black Tartary Oats.	Sandy Oats.
	No. 1	No. 2	No. 3	No. 4					
Grain in 100 parts,	76·4	77·99	77·39	74·26	76·80	76·28	71·86	72·38	76·28
Husk in 100 parts,	23·42	22·0	22·61	25·55	23·20	23·66	28·22	27·62	23·68

An average of the above gives 75·54 as the usual proportion of grain, and 24·26 of husk. I am inclined to think that this separation cannot be considered a *certain* indication as to quality, because the above Victoria oat, which afforded the largest per-centage of husk, was sent as a sample of peculiar excellence, having yielded an extraordinary quantity of fine meal to the boll. The thinness of the skin, in this instance, was more than an equivalent for the thickness of the husk.

2. Of the water in the oat at ordinary temperatures, the annexed table gives the per-centage in five of the ordinary varieties.

TABLE XXV.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Per-centage of water, . .	13·02	13·59	11·02	11·50	11·90

The mean of the above gives about 12 lbs. of water in 100, or about 5 lbs. in a bushel of oats, as they are when kept in a dry place at the ordinary temperature. This is probably somewhat below the true average, as my determinations were made upon oats that had been kept for some time in small parcels.

I was next desirous to ascertain how much of this water was contained in the grain, and in the husk respectively, and accordingly made trials of each part separately. The following table contains my results.

TABLE XXVI.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Per cent. of water in grain,	13·17	13·66	11·06	11·27	11·56	12·10
Do. do. in husk,	12·55	13·38	10·19	10·09	11·52	11·09

The difference is not great. It is singular that the husk should contain so very nearly the same per-centage as the grain, a body we should suppose so much more suited to absorb and retain water. The chaff, as we have seen, presents an analogous case.

3. The next inquiry relates to the quantity of ash, and is of much importance. I am now to show that in these two parts of the plant, the ash varies in quantity under different circumstances of growth, as we have found it to do in the parts already examined. I shall first give the husk and grain separately, and then the quantity yielded by the whole oat.

The annexed table gives the per-centage of ash in the dry husk and grain of different varieties of oats, grown on unlike soils.

TABLE XXVII.

	Hopeton, Light loam.	Hopeton, Poor moss.	Hopeton, Lime-sick land.	Hopeton, Reclaimed moss.	Potato, Thin gravel.	Dun, Good loam.	Sandy, Gravelly loam.	Mean of seven trials.
Ash in grain,	2·14	2·81	2·28	2·32	2·22	2·11	1·61	2·07
Ash in husk,	6·47	5·27	6·49	7·11	6·99	8·24	6·03	6·66

It appears from the mean of the above trials, that the husk contains three times as much ash as the grain. The variations of

ash in the different samples of each are not so wide as in other parts of the plant, but there are no two even of the same variety alike.*

The following table gives the per-centage of ash in the whole oat.

TABLE XXVIII.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Mean of eight trials.
Per cent. of ash in whole oat calculated dry,	3·17	3·32	3·37	3·25	3·56	2·58	2·66	3·65	3·19

If we take the above mean as near the true one, the bushel of 40 lbs. contains nearly 1¼ lbs. of ash; a crop of 60 bushels, therefore, carries off about 75 lbs. When the whole oat is burned, we find that the grain being in so much larger quantity, brings down the united per-centage of ash far below what is yielded by the husk alone.

Having now completed these preliminary inquiries, I turn to the consideration of the composition of the ash from the husk and the grain.

I shall now separate the two parts, and give the analysis of each in a distinct table.

1. *Composition of the Ash from the Husk.*—I have already shown that the ash of this part is three times greater in quantity than that of the grain, and that it constitutes about the third part of that which is taken from the land in the seed. In proceeding another step, and ascertaining its composition, I shall first direct attention to a table containing extended analyses of the ash from four specimens, grown in widely separated parts of the country, and of the two most common varieties, the Hopeton and the potato oats.†

TABLE XXIX.

		Hopeton.		
	Potato Oats, Northumberland.	No. 1. Northumberland.	No. 2. Wigtonshire.	No. 3. Ayrshire.
Sulphuric acid,	4·30	9·61	5·01	4·90
Phosphoric acid,	0·66	1·04	2·65	1·80
Chlorid of sodium, (common salt.)	2·39	0·24		
Chlorid of potassium,			2·37	0·40
Potash,	2·23	3·93	5·55	5·30
Soda,	8·97	6·33		
Lime,	4·30	1·95	4·31	2·03
Magnesia,	2·35	0·38	1·01	0·64
Peroxid of iron,	0·32	1·58	1·61	1·80
Peroxid of manganese,		0·92	0·86	0·72
Soluble silica,	5·79	4·46	2·91	1·61
Insoluble silica,	68·39	68·39	71·82	80·11
	99·80	98·83	98·10 F.	99·33 F.

* The grain burns with exceeding difficulty. The abundance of alkaline salts is so great that it is almost impossible to prevent their melting, and enveloping the carbonaceous matter. I have, in some instances, been compelled, after charring the grain, to dissolve out these phosphates, by boiling in successive portions of distilled water. The remaining ash then burns white. The alkaline solution is again added, and the whole evaporated to dryness. This method, *with care*, is perfectly accurate.

† The analyses marked F, are from Mr. Fromberg.

The very large per-centage of silica is one of the most striking features in this table. It amounts in every case to more than 70, and in Hopeton oats, No. 3, to more than 80 per cent, averaging considerably higher than in any other part of the plant. It is no doubt present in such quantity that the husk may be a proper covering to the grain. While the husk is yet green, the chaff, as I have stated, protects both it and the grain; but this is only until the husk arrives at maturity; it is then, by itself, admirably fitted to protect the grain, and the chaff is no longer necessary.

In the salts soluble in water, sulphuric acid still predominates; phosphoric acid is usually there also, but in minute quantities, and the phosphates in the acid solution seldom amount to more than 1 or 2 per cent. In two of these analyses there is no soda, neither is it found in the ash from the grain of the same oats. The two alkalies seem to fulfill the same purpose in the economy of the plant, and it appears to take one or both indifferently, as they are more or less abundant in the soil.

The above table has shown that the ash of the husk varies in its composition, but I have prepared another in a condensed form, which exhibits the fact more distinctly.

Composition of Ash from four samples of Oat Husk.

TABLE XXX.

	Hopeton Oats.		Potato oats, Gravelly soil.	Dun oats, Good loam.
	No. 1, Light sandy loam	No 2, Poor moss.		
Salts soluble in water, chiefly sulphates and chlorids,	22·92	33·84	23·14	19·96
Phosphates of lime, magnesia, and iron,	1·84	4·62	1·10	2·49
Lime and magnesia, ...	6·79	1·54	5·18	3·28
Silica, ...	68·55	60·00	70·57	74·25
	100·00	100·00	99·99	99·98

To the insoluble silica in each of the above, must be added 4 or 5 per cent. of soluble silica contained in the watery solution. The Hopeton oat husk, No. 2, on "poor moss," is the same to which I have referred before. It is less deficient in silica than any part of the plant to which it belongs. Its demands, as most imperative, seem to have been supplied first.

No part of the plant has so small a portion of salts soluble in water as the husk. From the instance of the Dun oat above, they may even be below 20 per cent. in a perfectly healthy sample, for this was inferior to none in general appearance and size.

2. *Composition of the Ash from the Grain.*—With this last part of the plant I shall follow the same plan as I have hitherto pursued, first giving extended analyses, and then directing attention to the differences caused by variety of soil, manure, &c.

TABLE XXXI.

	Potato Oats, Northumberland.	Hopeton Oats.		
		Northumberland.	Ayrshire.	Ayrshire.
Sulphuric acid,	. .	17·37		
Phosphoric acid,	49·19	38·48	46·26	50·44
Chlorid of sodium, (common salt,)	0·35	0·49		
Chlorid of potassium,	. .	. .	5·32	1·03
Potash, }	31·56	20·96	16·27	20·65
Soda, }				
Lime,	5·32	6·57	10·41	10·28
Magnesia,	8·69	11·00	9·98	7·82
Peroxid of iron,	0·88	0·38	5·08	3·85
Peroxid of manganese,	. .	. .	1·25	0·42
Soluble silica,	0·89	1·29		
Insoluble silica,	0·98	2·31	3·70	4·40
	97·86	98·85	98·27 F.	98·89 F.

In every part of the plant hitherto, we have found sulphuric acid in the watery solution of the ash; in the grain it seems to give way to phosphoric acid. In only one of the above analyses is it present; the grain was from a poor crop, grown on an exhausted soil, and it is possible that the sulphuric acid may have been present only because it was impossible to obtain a full supply of phosphoric acid.

The large quantity of this acid is remarkable; in nearly every case it constitutes almost or quite one-half of the ash. It is easy, therefore, to see how the addition of bones or guano should benefit the oat crop.

Silica, heretofore so prominent an ingredient in the ash, is here very small in quantity.

The second sample of Hopeton oats was grown on what is called lime-sick land, but it will be perceived that the proportion of lime is not larger than in some of the other ashes. This is in accordance with an opinion of Prof. Johnston, first suggested after an analysis of a lime-sick soil, that the defect does not consist in a superabundance of lime, but in a physical condition of the soil, produced originally by too large a dose of lime at once. The oats from this soil were very poor, the grain full sized but light. The quantity of chlorine is large compared with the others, as is that of the oxide of iron also, otherwise there are no very striking differences.

The grain constitutes three-fourths of the weight of the oat, and furnishes a little more than one-half of the ash; in which ash, if we consider 45 lbs. of phosphoric acid the average, a crop of 60 bushels will carry off about 68 lbs. of that acid, equivalent to about 300 lbs. of bones.

From the many analyses of grain that I have made, I will only select three, in addition to those which I have already given.

The three samples of oats to which the grain belonged were obtained through the kindness of my friend Mr. Simpson of Teawig, Beauly, Inverness. In accordance with my request, he selected specimens from the same neighborhood, grown on very unlike soils. They were of crop 1844.

"No. 1. *Sandy Oats.*—Grown on a stiff clay soil, which was much *baked* by the early summer's drought. They were after grass sown with wheat laid down after a crop of turnips, manured with farm-yard dung and a small quantity of bones. Crop, four quarters per acre."

"No. 2. *Hopeton Oats.*—Grown on a poor sandy soil, which also suffered much from the drought. The oats were after two years' grass, pastured, the grass sown down with barley, after a turnip crop (raised with bones), which was all eaten off on the ground by sheep. Produce, *three quarters* per acre."

"No. 3. *Hopeton Oats.*—Grown on a deep rich vegetable mould, one of the best soils in that part of the country. Managed in the same manner as No. 1. Produce, *eight quarters* per acre."

I will first give the per-centage of ash obtained from the grain of these oats, and then its composition.

Per-centage of Ash in Grain, from Mr. Simpson.

TABLE XXXII.

	No. 1.	No. 2.	No. 3.
Ash calculated dry, ...	1·80	1·48	2·48

The differences in this table are certainly very striking; after the above account of the soils, and amount of the crops, they scarcely need any explanation. The poorest crop has least ash. This is a very decisive proof of the absolute necessity of this small portion of inorganic matter to the grain. The scanty supply yielded by the soil of No. 2 seems to have made a difference of five quarters per acre in the crop.

We will now consider the composition of these ashes, as given in the following table.

TABLE XXXIII.

	No. 1.	No. 2.	No. 3.
Salts soluble in water, chiefly sulphates and chlorides,	68·52	70·96	72·96
Phosphates of lime, magnesia, and iron, . .	21·60	18·63	12·42
Lime and magnesia, ...	7·10	7·11	11·95
Silica, ...	2·78	3·30	2·67
	100·00	99·99	100·00

The chief differences in these ashes are in the lime and magnesia, and in the phosphates. It seems strange that the latter should be least in the ash of No. 3. This would perhaps be explained by some local circumstances, with which I am not acquainted.

The quantity of silica, in the ash of No. 2, from the sandy soil, is, as we should expect, somewhat larger than in the others.

On the whole, the differences between these ashes, are not very striking, and it would be hard to say from an inspection of the above, which had belonged to a poor crop. This fact is most worthy of attention, since, in so far as the present analyses go, they show that the plant will only produce as many *seeds* as it can bring to perfection, so far as the inorganic part is concerned. It may, and will, as we have seen, produce an imperfect straw, but the essential parts of the ash of the *grain* must always be present, and that too in the proper proportions.

Before closing my account of the inorganic part of the oat, I will introduce two tables, the first of which gives a comparative view of the per-centages of ash yielded by all the parts of the plant in different specimens, and the second an analysis of each of these parts united in one table, so as to give a comprehensive view of the whole.

1. *Comparative view of the quantity of Ash yielded by the different parts of the Plant. Calculated dry.*

TABLE XXXIV.

	Hopeton, Northumberland.	Hopeton, Fife.	Potato, Northumberland.	Dun, Edinburgh.	Sandy, Fife.	Mean of each part.
Grain, . .	2·14	1·81	2·22	2·11	1·67	2·00
Husk, . .	6·47	6·03	6·99	8·24	6·03	6·75
Chaff, . .	16·53	17·23	18·59	19·16	18·97	16·09
Leaf, . .	8·44	7·19	14·59	10·29	15·92	10·88
Top straw, .	4·95	5·44	9·22	8·25	11·01	7·77
Middle straw,	6·11	5·23	7·41	6·53	9·01	6·66
Bottom straw,	5·33	5·18	9·76	7·10	7·30	6·93

2. *Comparative view of the Composition of Ash from each of the above parts in Hopeton Oats, from Mr. Harbottle, Hexham, Northumberland.*

TABLE XXXV.

	Grain.	Husk.	Chaff.	Leaf.	Top straw	Middle straw.	Bottom straw.
Sulphuric acid, .	. .	9·61	5·32	14·80	16·33	18·45	13·29
Phosphoric acid, .	49·19	1·04					
Chlorid of sodium, .	0·35	0·24	5·11	2·29	3·13	3·03	15·36
Phosphates of lime, magnesia, and iron,	. .	. .	5·84	6·13	2·84	3·03	0·78
Potash, . . Soda, . .	31·56	10·26	7·96	14·89	19·09	21·80	43·17
Lime, . . .	5·32	1·95	4·53	6·99	7·02	7·23	6·06
Magnesia, . .	8·69	0·38	1·84	2·55	2·84	2·91	2·07
Peroxid of iron, .	0·88	1·58	0·24	. .	0·30	1·40	0·61
Peroxid of manganese,	. .	0·92					
Soluble silica, .	0·89	4·46	11·99	5·90	5·13	7·34	5·03
Insoluble silica, .	0·98	68·39	56·05	45·75	43·31	33·14	12·25
	97·86	98·83	98·90	99·30	99·99	98·33	98·35

Sprengel and Boussingault have published analyses of the grain of oats. Those of Sprengel are inserted in Prof. Johnston's Lec-

tures, and those of Boussingault in his own works. As all the results hitherto presented in this paper are original, I merely refer to these without introducing them.

I have now finished the course that I at first marked out for the inorganic division of this chapter. The plant has been divided into seven parts, the top, middle, and bottom straws, the leaf, the chaff, the husk, and the grain. The leaf was again subdivided into a bottom and top part. Of each of these nine parts it has been shown—

1. That it varies from every other, both in the quantity of its ash, and the composition of that ash.

2. That variations also exist between the ash from different specimens of the same part, grown on different soils.

3. That in these variations, although often very great, the distinctive character of the part is always preserved; the composition of the ash from the husk, for instance, never being like that from the straw or leaf.

4. That the soil has a direct influence on the quality of the ash. This has been proved in several instances, and particular deficiencies pointed out.

5. That each part is furnished with an ash—in quantity and quality peculiarly adapted to the function which the part is designed to fulfill.

The silica, for instance, is in the straw so distributed as most effectually to strengthen those parts which need its supporting power; in the leaf it sustains an extended surface of pores in contact with the atmosphere; in the chaff it forms an impervious coating for the husk, until that part has also received a supply which enables it to protect the grain, upon which the perpetuation of the species depends.

Equally beautiful are the facts which we discover respecting the alkaline sulphates and phosphates. We find little of the latter in the whole length of the straw, in the leaf, or in the chaff. But when we arrive at the grain, the alkaline sulphates disappear, and the phosphates take their place; these have passed up the whole length of the stalk, avoiding the leaves and the chaff, and at last, by a law infinitely more unerring than any which human wisdom can devise, deposited themselves in the very place where phosphoric acid is most needed, in order that, as part of the food, it may build up the bones, the framework of the animal body.

These are only two of the many theoretical deductions that we have been enabled to draw during our gradual ascent.

But it is not only such theoretical and physiological questions that have been elucidated by these analyses; they indicate many facts of great importance to the practical man.

The composition of every part of the healthy plant being known, the means for obtaining a healthy crop are obvious. The

inorganic part being entirely derived from the soil, to the soil must attention be directed in case of failure, and its deficiencies ascertained. With these results before him, any farmer may see that if his straw refuses to stand, the chief cause is probably a lack of soluble silica in the soil. In some of the alkaline silicates now manufactured for sale, he may find a ready means of remedying the defect.

The straw, it should be noticed, does not return to the soil all that the grain has taken from it, and thus even where all the straw is returned in the shape of manure with the greatest possible care, the land may ultimately become exhausted of the materials for the inorganic part of the grain, which is all carried away and sold. With these remarks I pass on to the second division.

II.—*Of the Organic part of the Ripe Plant.*

Under this division will come more especially the nutritive properties of oats. In the consideration of the inorganic part, attention was chiefly drawn to questions connected with the circulation of the plant, and with the best means of supplying those deficiencies which are invariably found when an imperfect crop is produced.

These inorganic substances, especially the phosphates, are indispensable to our food, but they form a small part of the whole grain, only 2 lbs. in 100. The remaining larger part merits our attentive consideration, particularly as it chiefly distinguishes the oat from other varieties of corn.

I speak here of the grain alone: that being the most important part, for its nutritive properties, I have confined my attention chiefly to it. I have also been able to make the husk the subject of a few researches. It would have been very interesting and useful to examine the straw also, but I was obliged reluctantly to conclude my observations, as the time for the delivery of this essay approached.

The proximate principles of the grain will first demand our attention, and it will be necessary, by way of preface, to give an account of the methods by which they were obtained.

The quantity of grain taken for analysis was from 75 to 100 grains.

1. This was rubbed thoroughly in a mortar, and successive portions of water added, until the starch, &c. was all washed away from the epidermis. The solution was allowed to stand in a cool place for twenty-four hours, and the liquid was then drawn off by a syphon. Fresh water was now added, and after some hours again drawn off; this was repeated until the liquid came away quite clear. The starch then remained pure, it was collected on a weighed filter and dried at 212°, until it ceased to lose weight.

2. To the solution drawn off from the starch, acetic acid was added, to throw down the casein or avenine. This was allowed to settle, and the liquid drawn off by a syphon of small bore. The precipitate was now transferred to a weighed filter. It is necessary to stop the washing while the water is still acid, otherwise a portion of the casein will be re-dissolved. It was now dried in the same way as the starch.*

3. The solution separated from the casein was evaporated to a very small bulk, and treated with strong alcohol to throw down the gum. After standing some hours the gum was collected on a filter, washed with alcohol, and dried as above.

For the remaining solution nothing more was determined.†

4. The epidermis, after separation from the starch as above, was collected in a retort, and boiled with acetic acid. On neutralizing the solution, a small precipitate of albumen fell. This was collected, and the epidermis boiled again in a very weak solution of caustic potash. On neutralizing the solution, another slight precipitate of some protein compound was obtained. This was so small in quantity that it was classed with the albumen. After this boiling with caustic potash the epidermis was collected, washed, dried, and weighed.

5. To determine the oil, sugar, and glutin, a fresh portion of grain, about the same weight as before, was taken and boiled with successive portions of alcohol, until a drop left no trace on evaporation. The solution was then carefully distilled to dryness in a small retort. The dry mass was treated with successive portions of pure ether to dissolve the oil; and this ethereal solution was carefully evaporated to dryness in a small weighed capsule.

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* This substance has been called casein, because in many respects it resembles some of the kinds of casein found in other bodies; but as its exact composition has not yet been determined, I use for it the provisional name of *Avenine* proposed by Prof. Johnston.

From the casein of milk, it differs in some important properties. Rochleder describes the casein of milk as *soluble* in *weak acid*, but precipitated by more acid and weak alkalies. *Insoluble*, when free from acid or alkali, in *water*.

I have found the casein of oats to agree more nearly with the casein of beans, as described by Liebig. He says, "It is soluble in *cold water*, *does not* coagulate by *heating*, is precipitated by dilute acetic acid, and is *not soluble* in an *excess*.

The casein of oats is *very soluble* in pure water, being nearly all dissolved by the first water added to the bruised grain. *Weak* acetic acid causes an abundant precipitate, which an excess of acid does not seem to re-dissolve, as no precipitate fell from the liquid filtered and neutralized by carbonate of soda. Boiling a portion of the original solution did not coagulate the casein, but after cooling, on the addition of acetic acid, the precipitate fell more quickly than before. When this was filtered and neutralized by carbonate of soda, a slight precipitate fell, showing that the casein was slightly soluble in an excess of acetic acid by the aid of heat, or that there was a small quantity of albumen present.

† I made some experiments upon the legumin of almonds, to which also this casein seems to bear some resemblance. A copious precipitate of legumin falls on the addition of a little acetic acid, but a small portion of it re-dissolves in an excess. From the strongly acid solution filtered and neutralized by carbonate of soda a slight precipitate falls.

After weighing, it is safer to re-dissolve the oil, and evaporate again, as some of the sugar sometimes finds its way over with it.

6. The mass left in the retort is now treated with water to dissolve the sugar; this solution is also evaporated to dryness in a small weighed capsule. It is an impure sugar, always containing more or less of the soluble salts of the inorganic part.

7. The substance originally dissolved by alcohol and finally left undissolved by water in the retort, was considered analogous to the glutin of wheat, and was accordingly set down as such in the analyses. It was collected, dried, and weighed, either in a cup or on a filter.

Having now described the process employed, I will proceed to give the results obtained by it in four specimens of grain, the same four of which the full inorganic analysis of the ash was given.

The soluble salts of the ash are in these analyses distributed to some extent among nearly all the substances. It is impossible to say how much water dissolves when the grain is unburned, and an indefinite quantity of this undetermined portion is thrown away in the solution from which the starch, &c. are obtained. The quantities contained in the precipitates can only be determined by burning them all. I have, in the following analyses, considered the greater part of the loss as alkaline salts, and have made the sums up to 100.

Proximate Composition of the Organic part, in four samples of the Grain of Oats. Calculated dry.

Table XXXVI.

	Hopeton Oats, Northumberland.	Hopeton Oats, Ayrshire.	Hopeton Oats, Ayrshire.	Potato Oats, Northumberland.
Starch, . . .	65·24	64·80	64·79	65·60
Sugar, . . .	4·51	1·58	2·09	0·80
Gum, . . .	2·10	2·41	2·12	2·28
Oil, ...	5·44	6·97	6·41	7·38
Casein, (avenine,) .	15·76	16·26	17·72	16·29
Albumen, . .	0·46	1·29	1·76	2·17
Glutin, . . .	2·47	1·46	1·33	1·45
Epidermis, . .	1·18	2·39	2·84	2·28
Alkaline salts and loss,	2·84	1·84	0·94	1·75
	100·00	100·00 F.	100·00 F.	100·00

In reference to the above table, we naturally turn our attention

1. *To the Starch.*—The four results are remarkably uniform. I am inclined to think, however, that the starch may be stated a little too low in this table, for reasons which will afterwards appear. As the table at present stands, the quantity of starch in the oat is nearest to that in barley.

2. *The Sugar.*—This, as I have said, is impure, and a little deduction should be made from its weight, especially in Hopeton oat, No. 1.

3. *The Gum.*—The quantities of this substance are nearly alike in the four trials: wheat contains a little more—about 3 or 4 per cent.

4. *The Oil.*—The quantities of *oil* given above are large, but I think correct. The earlier analyses of oats only give from three to four-tenths of a per cent. of oil. Both Boussingault and Johnston, however, have recently found from 6 to 8 per cent. This oil is of a beautiful pale yellow color, and its smell may be perceived on heating oatmeal cakes. The fattening qualities of the oat must be very great. The maize, or Indian corn, is celebrated for fattening animals; and Dumas gives only 9 per cent. as its maximum of fatty matters. Boussingault gives 7 per cent. as the average; while Leibig has denied that it contains more than 5 per cent. If we take 7 per cent. as the average, the meal of the oat, so far as the oil is concerned, should nearly equal that of the Indian corn.

5. *The Casein (avenine,) Albumen, and Glutin.*—These three I have grouped together as nitrogenous compounds. Their quantity is certainly very remarkable, being, in the potato oat above, a little more than 20 per cent. I have been led to think, however, that the quantities of all these compounds are a little overstated in the above analyses. Every one who has engaged in this kind of organic analysis knows the exceeding difficulty of obtaining the substances perfectly pure. I am somewhat suspicious that, in defiance of my precautions, my casein precipitates may have contained a little starch. I insert the above analyses, therefore, as open to correction.

In order to arrive at a more certain result as to the actual quantity of these nitrogenous compounds, I determined the nitrogen directly, by combustion in a number of specimens.*

The annexed table gives the result of nine of these combustions. Each burning was repeated two or three times.

TABLE XXXVII.

	Hopeton Oats.			Potato Oats.		Oats from Mr. Agnew, Ayrshire.			Imperial Oats, New York, United States.
	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 1.	No. 2.	No 3.	
Of nitrogen, . .	2·19	2·35	2·28	2·76	2·82	2·89	5·51	2·49	3·00
Of protein compounds,	14·00	14·78	14·04	17·36	17·77	18·24	22·01	15·66	18·86

This table shows a range of no less than 8 per cent. in the nitrogenous compounds.

* The nitrogen was determined by combustion of the grain in a mixture of caustic soda and lime in the usual way. The method of such combustions is so well known among all chemists, and so universally inserted in all recent chemical works, that it seems quite unnecessary to enter into a lengthened description of it here. From the ammonia-salt thrown down by platinum, the nitrogen is determined, and from the nitrogen the amount of protein compounds calculated.

Nos. 1 and 2, from Mr. Vans Agnew, were the first crop, after very old grass. No. 1 was manured with two cwt. of guano per acre harrowed in with the seed. No. 2 was *without manure.* This result is a most surprising one, and although I have repeated my trials, I feel that it needs still further confirmation. The crop being after old grass, the land must have been in good condition, and therefore would mature a crop even without the addition of guano, though that manure undoubtedly increased the yield upon the part to which it was applied. It is possible that on such a good soil with a healthy plant, the more slow growth and maturing of a less luxuriant crop than that to which guano was added, may have been more favorable to the largest possible amount of nitrogenous compounds; so that, while the seed was less in quantity, it should be richer in quality. The opinion somewhat prevalent among farmers, that guano turnips or potatoes are less nutritious than others, seems to countenance this view.

The Potato oat, No. 2, was also from a very fine crop, as was the American imperial oat, which was remarkable for its weight. The three samples of Hopeton oats were all from rather inferior soils, and poor crops.

But even if we take the lowest per-centage of protein compounds, they amount to 4 per cent. more than is stated to be the average quantity in wheat. The mean may, probably, be safely taken as 16 or 17 per cent.

Before concluding the organic part of the grain, I wish to give some account of the organic part of the husk, and afterwards some determinations in which the two parts are united.

I did not make a complete analysis of the proximate principles of the husk, but determined the oil and sugar only, by boiling in alcohol and ether, as described under the analysis of the grain.

The following table gives the results in two samples of husks calculated dry :—

Table XXXVIII.

	Hopeton Oats, Hexham, Northumberland	Potato Oats, Park End, Northumberland.
Of oil, ...	1·50	0·92
Of sugar and gum, . . .	0·47	0·75

Besides these substances, there was a considerable quantity of some nitrogenous compound left undissolved by water, somewhat analogous to glutin, and amounting in one instance to 1·28 per cent. The husk, then, is by no means without value for feeding. A determination of the nitrogen by combustion, shows that in addition to $1\frac{1}{2}$ per cent. of oil, it contains at least $1\frac{1}{2}$ per cent. more of protein compounds.

The following table gives the nitrogen in the husk and grain separately, and afterwards in the whole oat of the same sample. The results calculated dry:—

TABLE XXXIX.

	Husk.	Grain.	Whole Oats.
Of nitrogen, ...	0·30	2·82	2·18
Of protein compounds, . .	1·88	17·77	13·72

A proximate analysis of Boussingault's gives 13·7, as the amount of protein compounds in the whole oat, exactly coinciding with the above determination. We see, then, that even including the husk, the oat is superior to almost any other corn, in those ingredients which go directly to the production of muscle in the body. The strong muscular forms of the Scottish ploughmen have long been living witnesses to the good properties of their favorite and almost only food; and now that it has been shown what those properties really are, I feel sure that Dr. Johnson's definition of oats—"Food for men in Scotland, and for horses in England"—will be remembered only for its appropriate answer—"And where will you find such men and such horses?"

In conclusion, I may be permitted to say, that the extent of this investigation, and the many points which I have been compelled to leave undetermined, or doubtful, after eighteen months of constant labor, must convince those who entertain false ideas of the time and patience necessary for chemical researches of this kind, that they have erred in supposing the chemist able to do in a few days or weeks, what can only be effected by the labor and study of many successive years.

In presenting my results to the Society, it is with a consciousness of their imperfections, and a feeling that it would have been most desirable to extend them much further in every direction.

At the same time, I think that much *new* ground has been gone over, and that in many respects the bounds of our knowledge, with regard to the oat plant, have been considerably enlarged.

I have endeavored to condense rather than extend my conclusions and descriptions, which might have reached a very great length indeed, from the mass of tables and facts now presented.

Laboratory of the Agricultural Chemistry Association, October, 1845.

ART. XXXII.—*On Free Electricity;* by ROBERT HARE, M. D., Professor of Chemistry in the University of Pennsylvania.

PRACTICALLY there is a striking difference between the excitement of an electrified insulated conductor, the prime conductor of an electrical machine for instance, and the charge of a coated pane or Leyden jar. In the one case diruptive discharge is productive of a comparatively short thick spark, in the other of a spark distinguished by comparative length and tenuity. The discharge from the pane or jar is productive, for equal surfaces, of a much greater shock than could result from a spark ten times as long, from the conductor of the machine by which the electricity is generated. And yet if the intensity be inversely as the square of the striking distance, it must be a hundred times as great in the case of the conductor, as in that of the coated surfaces.

Electricity, as it exists in the conductor, has been called free: as it exists about the coated pane, has been called simulated or disguised. Yet Faraday has alleged "that the charge upon an insulated conductor in the middle of a room, has the same relation to the walls of that room, as the charge upon the inner coating of a Leyden jar has to the outer coating of the same jar." "The one is not more dissimulated than the other." "As yet no means of communicating electricity to a conductor, so as to place its particles in relation to one electricity and not at the same time to the other, in an equal amount, has been discovered."

It seems to me that these opinions of Faraday have been judiciously criticized by Mr. Goodman in the London and Edinburgh Philosophical Magazine and Journal, Vol. xxiv, p. 174.

It appears likewise that opinions harmonizing with those of Mr. Goodman, have been entertained by Charles V. Walker, Hon. Sec. L. C. S., as may be seen in the Proceedings, Dec. 20, 1842. Agreeably to Mr. Walker, lightning resembles the discharge from a prime conductor, not that which takes place between the surfaces of a coated pane or jar.

I will proceed to state the considerations which induce me to concur in opinion with Mr. Goodman and Mr. Walker.

If two sufficiently remote insulated metallic disks, such as usually enter into the construction of an electrophorus, by due communication with the rubber and collecting points, be made to serve, one as the positive, the other as the negative conductor of an electrical machine in operation, a diruptive discharge from either may be obtained, by the approximation of an uninsulated conducting body, or one communicating with one conductor while approximated to the other. When this discharge takes place from a small knob on the positive side, to a large one on the negative side, of the circuit, the resulting spark is compara-

tively long, and by its zigzag form represents lightning in miniature.

If, in the next place, a sufficiently large pane of glass being interposed, the disks be made to serve as a coating to the glass, the surfaces of the pane which they touch will become oppositely charged. If immediately after the charging is effected, both disks being insulated, the knuckle of the operator, or any other conducting body in communication with the earth, be approached to either disk, a spark will pass, and on contact, a certain portion of electricity will be discharged. This is what I would call free electricity: but on making a conducting communication between the disks acting as coatings, a much larger discharge of electricity will take place. This is what I would call neutralized or dissimulated electricity. But the ratio in quantity of the latter to the former, varies evidently with the thickness of the pane or panes which may be interposed; so as to be inversely as the square of the distances of the charged surfaces. If a stratum of air perform the part allotted as above to the panes, the same law must hold good. But when instead of flat disks, corresponding in size and shape, we substitute a cylindrical or globular metallic mass, such as is generally used for the prime conductor of an electrical machine, on the one side, and on the other side the walls, floor, and ceiling of a room, for the other surface, evidently the ratio of the free electricity to that which can be neutralized, must be enormously great. Supposing the glass pane to be one-tenth of an inch in thickness, the distance between the surfaces of the conductor and the parietes of the room to be ten feet, the quantity of electricity neutralized in the case of the pane will be to that neutralized in the case of the conductor as the square of one to the square of twelve hundred inversely; or in other words nearly as a million and a half to one. It follows that in the phenomena of discharges from a prime conductor the neutralizing or dissimulating influence of the conducting superficies opposed to it must be too small to be regarded.

The allegation of Faraday, that no mode has been discovered by which to place the particles of a conductor in relation to one electricity, and not at the same time to the other, is verified, as Mr. Goodman has observed, when the friction between the rubber and glass takes place. The glass becomes positive to precisely the same extent as the rubber becomes negative; but when the vitreous surface thus excited moves away from the rubber, the compensating electricity of the rubber being no longer at hand, that upon the glass cannot realize Faraday's idea, excepting so far as it may be competent to act upon the walls, ceiling, and floor of the apartment, as electricity on the inner surface of a Leyden jar acts upon the outer surface. But in the case in point, the electric interposed is so enormously thick, compared with the

glass in a Leyden jar, that very little of the inductive influence can avail to produce an opposite state tending to neutralize the electrical excitement "to an equal amount."

Just so far as it can produce an equivalent opposite state, it becomes dissimulated or neutralized; so far as it does not, it is free, or, in other words, exercises that uncompensated activity which has, in my opinion, justified the distinction made between free, and dissimulated, neutralized, or latent electricity.

It will be perceived that I concur with Mr. Walker in the opinion, that on account of the distance of thunder clouds from the earth, the electricity which they may acquire is too remote from the terrestrial surface to induce in this an opposite electrical state, capable of neutralizing the electricity of the cloud beyond a minute proportion.

There seems to be an obvious means of discrimination between free and neutralized electricity, in the fact, that the one is associated with the surface of a conductor, so as to accompany it when moved, while the neutralized electricity is inseparable from the superficies of the electric, through the intervention of which it exists. It is well known that the coatings of a pane or jar may be removed without disturbing the charge which may have been imparted by their presence. Yet if removed after the pane is fully saturated, each coating will hold a charge which it will give out in a spark to any uninsulated body, without any reference to the other coating which may meanwhile be remote and insulated from all communication with it. The spark thus yielded has the characteristics of free electricity. Having served as a part of the conductor, with which it had communicated, the coating is surcharged in proportion to its capacity, and gives up the redundancy on communicating with the earth, without any reference to the other coating. The spark thus given I conceive to have the characteristics of free electricity.

In the case of electric accumulations in the atmosphere, there can be no substitute for the service performed by glass in Leyden charges but that which air can render; and it can hardly be conceived that while agitated, as it is during thunder gusts, a stratum of that fluid can perform the part of a glass pane.

Art. XXXIII.—*On Zoöphytes*, No. V.; by James D. Dana.

Classification of Zoöphytes.

General Remarks on Classification.—It has often been justly said, that there can be but one strictly natural classification in either of the organic kingdoms. Yet if we look upon any system presented in the usual order on paper, as correctly and completely *the* natural system, we greatly mistake nature; for the various affinities cannot be fully expressed on a plane surface. The lines are so many, and so interlaced, that to be understood, they must be conceived of as ramifying in space. The mind, proceeding properly to its work, determines first upon those qualities which are physiologically of the most fundamental importance: it follows out the variations of structure under the grand divisions thus ascertained, fixing its attention successively upon qualities of a less and less general character; it traces the species through the various modifications in these several particulars, marking out the lines of gradation in affinities, observing some, it may be, partly isolated and terminating abruptly, others graduating into the different series by frequent blendings or anastomosings, and often between different lines detecting a serial parallelism: in this way the network is finally completed to the mind's eye.

When the relations are fully understood, we are ready to divide off into classes, orders, and the smaller subdivisions, cutting the threads here and there, as shall best exhibit the general character of the whole, remembering to make the corresponding divisions of equivalent importance and character. The institution of these various groups is not properly classifying; for the classification is completed when the branchings and interlinkings of affinities are made out. Subdivisions with appropriate names are, however, necessary, to aid the memory and convey this knowledge in words. Genera are convenient artificial sections, based on natural affinities; and very commonly they shade almost imperceptibly into one another. Whoever has attempted to lay out classes and their families and genera, has perceived the interlinkings, and felt the perplexity they produced. It may often have seemed vexatious to the systematist to have had a *well characterized* family or genus spoiled in its characteristic, and *exceptions* introduced, by the discovery of new species which blend it with another group, before considered quite distinct. But such perplexities will not be perceived, if we follow nature with docility, and make it our aim to bring out prominently the various shadings between subdivisions. The true object of classification is not to dissect the departments of life into as many distinct parts as possible for display like anatomical preparations; but to illustrate the system

of nature in its unity, and exhibit the myriad parts blended in one concordant whole.

The modifications of structure in living beings evidently proceed, to a great extent, from the nature of the world we inhabit, and the general laws and necessities of life. There are air, earth, and water, and these have their varieties of condition. Plants and animals offer other sites for living beings. The same circumstances may be said to call for the variety of size which exists in nature, for otherwise there would be possible conditions for existence unoccupied. The general nature of life, and its modes of exhibition, with the primary systems of structure, being determined upon in infinite wisdom, we need attribute no other plan to creative power than that of the simple adaptation of life, as thus constituted, to the conditions the world affords. Circles and numerical relations may amuse the imagination: but we have no evidence that the hand which made, was confined by such prescribed courses. We cannot fail to see, however, that in the primary plan of structure in living beings, certain organs or their parts, through extended groups, have been limited by fixed numbers: and this is so distinct in some classes, that it becomes an interesting study to trace out the sources of variations from the typical number.* We see the boundless resources of nature's Author displayed with greater force, the fewer the types from which an infinite variety might proceed; but not in any limiting of the number of species constituting groups.

Among the organs upon which the range of characters in the animal kingdom depends, the nervous system takes necessarily the precedence, for, as has been said with much propriety, this system is itself *the species;* since upon its characters, in connection with the general laws of organic growth, depends in a very great degree the nature of the individual. Next to this, come those organs which are intimately connected with the sustaining of life, *primarily*, those pertaining to respiration and circulation, and *secondarily*, those adapted to the receiving and digesting of food; and next, or of parallel value with the last, the provision for the continuation of the species. The means of locomotion and the associated structure, constitute a characteristic intimately

* Milne Edwards has well illustrated the fact, that *seven* is a normal number in Crustacea, the cephalic, thoracic and abdominal parts, each consisting normally of this number of segments, and variations taking place by a union of two or more segments, or by subdivisions; and this same law extends even to the joints of the legs and antennæ. The prevalence of such a law through so large a class, affords a sufficient ground for belief that specific numbers have not been entirely disregarded in any branch of nature; though the actual exhibition of them has been obscured in ways not understood. We cannot disbelieve, therefore, that numerical relations were involved in the plan of creation; yet, while admitting them as regards the *nature* of organic structures, we do not admit that the *number* of structures made on any particular type, had reference to any similar ratio.

connected with the causes just mentioned. Under the several grand divisions to which we are led by the above considerations, there are subordinate variations arising from the adaptation of life to minor differences in the conditions of existence around us:—such as minor differences of soil, (if we may extend this word to all those varieties of sites, afforded by the air, earth, water, vegetable and animal structures, variously modified by temperature, light and pressure); differences in the modes of taking prey or food of whatever kind, and in some peculiarities of the organs of digestion; certain differences depending on the sexual relations, and the means of preserving and developing the young, varying with the modes of existence alluded to; modifications of the provisions for self-preservation against enemies. These minor differences are exhibited in two ways: either particular organs retaining the *same* functions, undergo modifications in form and structure; or with other modifications, they subserve the purposes of *different* functions. When adaptations to different circumstances or purposes take place by variations in corresponding sets of organs or parts of organs, the relations produced are termed *homological;* and the relations are *analogical*, when they depend on a similarity of function, however produced.*

As the several families or classes of animals are exposed, in some respects more or less general, to the same circumstances, they would naturally undergo, in many instances, either *homological* or *analogical* modifications, occasioning that serial parallelism alluded to on a preceding page. And again, as the animals of the same class may be fitted to many different circumstances in nature, other parallelisms should exist, of a wider character.

The order in which the above sources of distinctions in the animal kingdom are mentioned, may be in the main nearly that

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* Prof. R. Owen, the eminent comparative anatomist of England, mentions three kinds of homology, viz: "general," "serial," and "special." "General homology is the relation in which a part or series of parts stands to the ideal or fundamental type; and thus, when the basilar process of the occipital bone in Anthropotomy is said to be the 'centrum' or 'body of the last cranial vertebra,' its *general* homology is enunciated. When it is said to repeat, in its vertebra or natural segment of the skeleton, the body of the sphenoid bone, the body of the atlas, and the succeeding vertebral bodies or centrums, its *serial* homology is indicated. When the essential correspondence of the basilar process of the occipital bone in Man, with the distinct bone called 'basi-occipital,' in a crocodile or a fish is shown, its *special* homology is determined."—*Phil. Mag.*, xxviii, iii ser., 526, June, Sup. 1846.

We refer the reader also to a very excellent paper "on the Structural Relations of Organized Beings," by H. E. Strickland, F. G. S., Phil. Mag., xxviii, iii ser., 354, in which the subject of affinities in organic beings, is presented in a clear and philosophical light. In addition to the terms *homology* and *analogy*, Mr. Strickland proposes the word *iconism*, to express *resemblance of form without a similarity of structure or function;* for example, the resemblance of the flower of the pea to a butterfly, or the shell Haliotis to an ear; and it includes also resemblances between species arising from accidental coincidence of color; while *analogy* includes such resemblances as depend upon a similarity of function.

of their relative importance. Yet it is well known that a set of characters valuable in one group is worth nothing in another: and this holds true in some cases even with those characteristics that are in general fundamental. It seems at first a violation of all propriety, to arrange together animals having gills, and those that have none; those that have a heart, and those that are destitute of even a vestige of one beyond a distant valve or two in the circulating system; those that have distinct arteries, and those whose arteries are only the lacunal passages among the muscles and other organs. Still this may be in accordance with a philosophical classification. The class Crustacea actually illustrates each of the three anomalies just stated. If the singular Amphioxus is truly a fish, as many ichthyologists affirm, we may have a vertebrate animal without a brain, and without a sense to raise it above the Polyp. In such cases, the system of structure typical of a group, is ascertained by a general study of the species, and then an acquaintance with this structure assists in tracing out transitions, and determining how far one and another organ may fail without requiring an entire separation of an individual from the group.

To classify, requires therefore the widest possible range of knowledge of organic beings, and the nicest balancing of affinities: and we remark again that it consists rather in expressing the various chains of affinities or homologies direct and parallel, with their shadings and blendings, than in searching for certain inviolable characteristics for distinguishing groups of species.

Classification of Zoophytes.—In view of the foregoing principles, any classification of Zoophytes made out without reference to the structure of the animals must necessarily be faulty. There have been several of this kind in the department of corals; and as the subject has been little understood till within a few years past, their errors were to be expected. They subserved, for the time, the purpose of systematizing the facts known, and afforded a means of characterizing species: so far, they were good. But at the present day, to make out a classification based on the corals alone and the easiest method of distinguishing them, would partake of times of past ignorance: they can no more be properly arranged without reference to their animals, than shells without regard to their molluscs. The zoological relations of the species should be first studied, and afterwards such characters laid down for the corals, as belong to the orders and families thus deduced.

The first classification of Zoophytes in which the animals received attention, was offered by Blainville.* Lamarck had led

* Manuel d'Actinologie ou de Zoophytologie, par H. M. D. de Blainville. 644 pp. 8vo, with an atlas of 100 plates. Paris, 1834. (The printing began in 1830.)

the way with a discriminating study of the corals. Blainville availed himself of the observations of Quoy and Gaymard, besides the few investigations of older authors, and with great acumen, made out an arrangement, which in its general features was highly natural. He divided Zoophytes, *including the Actiniæ*, into the groups *Zoantharia*, *Polypiaria*, *and Zoophytaria;* and if we strike out from Polypiaria a few species that belong with the first division, and others that are Bryozoa, we have the groups Zoantharia and Zoophytaria corresponding to the groups *Actinaria* and *Alcyonaria*, of the classification by the writer, and Polypiaria nearly to the *Hydroidea*. The only other change of importance which the writer has proposed in these primary subdivisions, is the union of the Actinaria and Alcyonaria into a single group, *Actinoidea*, equivalent in importance to Hydroidea. Blainville was the first author who actually introduced coral zoophytes fairly into the animal kingdom by his mode of describing and arranging them. He did not call the department a branch of zoology, and then describe corals as if they were *porous, stelligerous stones*, which is even now in many instances the case.* Still he speaks of the cells as *containing* the polyps, which is the reverse of the fact.

Ehrenberg in 1834,† after a more thorough acquaintance with coral animals obtained by investigations in the Red Sea, made some important improvements in the minor subdivisions; but his grand divisions were unfortunate. He separated in many cases the attached from the unattached species, and again, the simple from the compound, and thus broke up the natural assemblages which Blainville had made out. Even the natural group Alcyonaria, (Blainville's Zoophytaria,) is subdivided by him, and the parts widely separated. His system, notwithstanding some anomalies, exhibits great reach of mind and searching investigation. He removed correctly the Bryozoa from other Zoophytes, and first suggested the relation of the Millepores and Favosites to the Madreporacea. He pointed out the true nature of coral secretions, and described the mode of reproduction by spontaneous subdivision, which had not before been noticed. The modes of growth were also to a considerable extent described by him, and important use made of them, though not always correctly, in the classification of Zoophytes.

Milne Edwards, whose acquaintance with Zoophytes had been extended by a personal examination of many species, and by a thorough study of the labors of others, besides a comprehensive

* In descriptions of corals, (the *internal* or *basal* secretions of Zoophytes,) those characters which belong to the Zoophyte ought to be first stated, such as the general form, mode of growth, &c; and afterwards, separately, whatever, not already stated, may require mention with respect to the coral itself.

† Abhandl. der Königl. Akad. der Wissensch. zu Berlin, for 1832, pp. 225–438.

knowledge of nature, proposed, in 1837, a brief outline of a classification, which as far as detailed, exceeded those preceding it, in philosophical character. The Hydroidea, ("Sertulariens,") the Actinaria, ("Zoanthaires,") and the Alcyonaria, ("Alcyoniens,") are laid down as the grand divisions, and without the striking violations of affinities which appear in Blainville's order Polypiaria. We only observe that the Favosites are separated from the Madreporacea, with which group they were placed by Ehrenberg, and where they beyond doubt belong.

These are the principal authors since Lamarck, who have undertaken a general arrangement of the class of Zoophytes. The "Stony Corals" have quite recently been arranged mostly from the corals alone by Mr. J. E. Gray, of London.* We may express the belief, without entering into any criticisms on his classification, that with a more extended study of the animals and their corals, he would not have separated the *Milleporæ* and *Helioporæ* so widely from the *Pocilloporæ;* the *Stylastridæ* from the *Sideroporæ;* the *Montiporæ* from a part of Lamarck's *Porites;* the *Fungiæ* from the *Pavoniæ:* nor united into a single group the *Pavoniæ* and many *Astrææ;* nor the *Fungiæ*, *Flabella*, and *Meandrinæ:*—in the last case giving an unreal importance to the oblong shape of the Flabella, and implying a relation which is wholly without foundation between the oblong cell of the Meandrinæ, Flabella, and Fungiæ, for in the *first*, the form arises from budding, in the *second*, it is the shape of the polyp's disk, and in the *third*, the cell is only a depression *at the center of the disk*, and the form has not even generic importance.

Before giving a general view of the classification of Zoophytes, to which the writer has been led by the study of coral animals,† the importance of different characters as a basis of classification may be briefly considered.

Owing to the simplicity of polyps, there are few organs or functions to afford distinctive characters. They are as follows: I. The digestive system; II. The ovarian; III. The modes of budding and growth; IV. The tentacles and general character of the exterior; V. The secretion of coral and its nature.

I. The *Digestive System.*—In this system the stomach varies (1) in length as compared with the internal or visceral cavity

* An outline of an Arrangement of Stony Corals, by J. E. Gray, F. R. S., &c. Annals and Magazine of Natural History, xix, 120, Feb. 1847.

† As it may be of some importance to those interested in the department of Zoophytes, the writer here states that the animals of more than sixty species of coral animals, exclusive of Alcyonaria and Hydroidea, and pertaining nearly to every genus, have been figured by him, from living specimens obtained in the Pacific and East Indies, and these figures will appear along with others of different corals whose animals were not obtained, in the forthcoming Atlas to accompany the Report on Zoophytes.

below, and (2) in the character of the parts below and around it. In the *first* particular, the difference is one of less general importance than has been allowed; the relative length in the *Actiniæ* and most Actinoid corals, is between *four-fifths* and *one-third;* in the *Zoanthidæ* it is between *one-third* and *one-sixth;* in the *Alcyonaria*, between *one-third* and *one-twentieth;* in the *Hydroidea* the stomach is sometimes much shorter in proportion than in many Alcyonaria, though often far longer. In the *second* particular the difference is wide, the Actinoidea having the stomach suspended within the visceral cavity, and attached to the sides of the polyp by a radiating series of vertical fleshy lamellæ, which are wanting in the Hydroidea. The visceral cavity is a simple tube in the latter, and is radiated with vertical lamellæ in the former: but these peculiarities are also connected with the modes of reproduction. We omit other less obvious points of difference.

II. *Ovarian System.*—In this system, ranking in importance with the digestive, the absence of special organs with spermatic and ovarian functions, distinguishes the Hydroidea, and the existence of such organs, the Actinoidea. No character can be of higher value, or more marked in its attending peculiarities.

Among the Actinoidea, there is a great variation in the number of genital lamellæ, and in the relative position of the two kinds, the spermatic and ovarian. In the *Alcyonaria* there are uniformly *eight* in all; in the *Actinaria*, either *six*, *twelve*, or *more*.* In many of the latter division if not in all, the two kinds of lamellæ, (spermatic and ovarian,) are distinct: in some of the former, the same lamella is ovarian above, and spermatic below, or two are spermatic and the rest ovarian; or perhaps other conditions may exist. There is good reason for separating the *Alcyonaria* from the *Actinaria*, but not for making each division equivalent in rank to that of Hydroidea.

III. *Process of Budding and Growth.*—1. We find that the fact of species *budding* or *not budding*, is not connected in Zoophytes with any peculiarity of structure that can be detected, and farther, the transitions are gradual and frequent. This character, therefore, as it indicates no difference of concentration in the ner-

* A passage of the Actiniæ into the Alcyonaria may perhaps be observed in the *Lucernariæ*, which have a four or eight-lobed summit; and other Actiniæ approximate to this lobed character. These lobes bear a number of tentacles, or correspond to a number; and hence analogy suggests that possibly in the Alcyonaria each tentacle properly corresponds to two tentacles or more, or to a lobe in the Actiniæ alluded to. This view is borne out by finding in the larger Alcyonaria, the tentacles having a size wholly incompatible with the structure of the Actinaria; for the writer has shown in another place that in the Actinaria there are limits to the relation between the number of tentacles, as well as the width of interval between the genital lamellæ, and the size of the animal. Whether the analogy holds or not, the facts show striking differences between the Actinaria and Alcyonaria. See further, Report on Zoophytes, pp. 34, 123, and this volume, p. 7.

vous system, is entitled to little consideration as a means of distinction in the classification of these animals:—it is no more important here than in botany, where a plant consisting of a single individual bud, may be placed along side of one which consists of several. It may sometimes however be used to distinguish genera: yet in the genus Fungia, there are a few species that increase until they consist of two or three individuals; and there is thence a passage to the *Herpetolithi*, Eschsch. (Haliglossæ, *Ehr.*) and *Polyphylliæ*, Q. and G. The simple and compound Cyathophylla are other examples of the difficulty of this separation.

2. But the *modes of budding and growth* are of higher character; especially the distinction of *superior* and *inferior* gemmation, in the former the buds being terminal or at summit, and in the latter lateral or basal. It is of little importance whether the summit-widening, which accompanies superior gemmation, takes place in the disks, or just exterior to the disks. In either case, the visceral lamellæ are prolonged at top beneath the upper surface, by the process of growth, and hence such species have the upper surface of the corallum lamello-striate.

3. In superior gemmation, when the disks widen and bud, they sometimes subdivide as each new mouth opens, and sometimes not till several mouths have opened. This difference (distinguishing the genera Astræa and Meandrina) is of small importance. There are Astrææ in which the disks become 2 or 3-compound before they subdivide; and thus the two genera graduate into one another. There are simple and meandrine *Mussæ*, Oken, (Lobophylliæ, *Bl.*) between which no line of separation can be drawn, and they have been always retained in the same genus. The Monticulariæ, in the same manner, are related to the Meandrinæ.*

4. There is a group of species having superior gemmation, in which the disks have no proper limits; and in the compound species, the surface is a single disk with many mouths and scattered tentacles, (the latter often obsolescent.) The *Fungiæ* are examples of simple species of this kind; and the *Polyphylliæ*, *Pavoniæ*, &c., (including the *Astræa siderea*,) are compound species. The coralla of compound species are characterized by the continuation of the lamellæ of the stars from centre to centre, without interruption along a medial line; and they have no cells except it arise from a prominence of the intervals between the polyp-mouths. They thus differ from the *Astrææ;* for the cells in the *Astrææ* correspond to the visceral cavities of the polyps.

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* See on this subject Report on Zoophytes, pp. 76, 77, and this volume, p. 19.

5. Growing *free* or *attached* is a character of minor importance. It is sometimes a convenient *generic* distinction, as with the *Fungidæ*, but in other cases cannot be appealed to. All species, as is well known, are attached in the young state; and the time of becoming free varies with the species, some earlier and some later. The *Flabella* thus pass so gradually to attached species, and the animals in the two cases are so completely identical, that the separation can be sustained only on the ground of convenience in a distribution. We add that in this last mentioned case, the simple species pass as gradually into the compound, and they are closely connected with the group *Euphyllia*, D. (a part of *Lobophyllia*, Bl., having entire lamellæ.)

6. Growing *massive*, or *calicularly branched*, (aggregate or segregate,) is sometimes a good generic distinction. But polyps in contact grow together so readily that it can be of importance only when supported by other characters. In the group *Manicina*, no line can be drawn between the segregate and coalescing species; and the *Cyathophylla* are other examples. Difficulties in the way of characterizing groups thus arise, which must be fairly met and not denied nor overlooked.

7. The *forms of growth*, whether branching, massive or explanate, afford good distinctions for species, but seldom generic characters. We find *explanate* and *massive* Gemmiporæ and Porites; *explanate, massive*, and *branching* Porites and Manoporæ; and *explanate* and *branching* Merulinæ and Echinoporæ. No more unfortunate generic character can be laid down than one drawn from this source: it may, however, be occasionally used, when sustained by other characters. The genus *Explanaria* of Lamarck is an agglomerate of species of several genera.

We have elsewhere shown that the sizes of branches, the frequency of branching, and the width of intervals in groups between branches, are good trivial characters within certain limits. But in all cases in instituting species, the specimens examined should be good and full grown, and not fragments.

8. Growth by budding from an apical polyp, or from serial budding, are points that may afford good generic distinctions.

IV. *Tentacles and General Character of the Exterior.*—In many genera, the tentacles are too short to take any part in the prehension of food, and apparently subserve only the purpose of aeration. As the whole body takes part in this function, the size of the tentacles must necessarily be unimportant as a family character. Hence we find, even in the same genus, (*Fungia, Porites,*) species with comparatively long tentacles, and others in which they are almost obsolete. The species of the genus *Actinia*, are almost as various in the sizes of the tentacles. Among the *Astrææ*, one species was observed by the writer, in which the place of tentacles was supplied by numerous spine-like processes

over the surface between the disks; and the same is true of the *Echinoporæ*, or at least partly so, for the writer observed no tentacles in the two species he examined. The same reason shows that the moss-like subdivision of tentacles, observed in some Actinidæ, is a character only of generic importance, for it takes place generally in such species as live more or less buried in the sand or mud, which fact seems to require an extension of the aerating surface, such as this delicate branching affords.

The *number* of tentacles appears to have a relation to two distinct series; in one the number is *six*, *twelve* or *more*, with the alternate usually unequal when exceeding six, (and always so, when over twelve:) in the other, *eight* simply, and all equal. The *character* of the tentacles is different in the two series, the former (the Actinaria) having them naked; the latter (Alcyonaria) having them fringed with perforate papillæ. A large number of species of Actinaria are characterized by *twelve* tentacles, and have been separated to form the group Madreporacea; but notwithstanding this point of resemblance, the several genera are as closely related to species having a greater number of tentacles.

The occurrence of suctorial vesicles on the lateral surface or disk, is a character of only generic importance.

Color is seldom of much importance, even for trivial distinctions. Yet the mode of arrangement of colors may be characteristic of species. A mutual dependence or relation of certain colors may possibly be hereafter ascertained, by which a knowledge of one will determine the others that may be possible in a species; and in such a case, the character may have a value which cannot now be allowed it.

V. *Secretion of Coral.*—1. The *secretion* or *non-secretion of coral internally*, is at the best no more than a family distinction; and among the *Alcyonaria* it is only generic. This is an admitted truth with regard to calcareous secretions among Molluscs; and Olivi and Blainville long since acknowledged it with reference to zoophytes.

2. The *secretion of coral at base, distinct from internal secretions*, is a characteristic of much value; it produces the structure of the *Gorgonia* and allied zoophytes, and also of the *Antipathi*.

3. The *nature of coral secretions* sometimes affords generic distinctions, and with other characters, in some instances, distinguishes the higher divisions of zoophytes. The *Hydroidea*, as far as known, never form any but membranous or horny coralla. The *Astræacea*, *Caryophyllacea* and *Madreporacea*, secrete only calcareous coralla, excepting a few marine Actinidæ, (*Actinectæ*,) which form a cellular membranous float at base to keep them at the surface. The *Antipathi* form only basal horny secretions, and therefore have a horny axis. The *Alcyonaria* are more various in this character, the different genera having their peculiar-

ities; the *internal* secretions are always calcareous and in *grains* or *spiculæ*, and in this last particular they differ from the calcareous of the Actinaria; these grains are sometimes so abundant as to unite into solid tubes, (*Tubiporæ.*) The *basal* secretions are either horny, (*Gorgoninæ*,) calcareous, (*Corallium*,) or siliceous, (*Hyalonema ;*) and in some instances, from a mixture of membranous tissue with the earthy matter they resemble cork.

4. Among the calcareous corals, the texture or density of the coral is often of little importance, as it may vary in different parts of the same specimen, according to their full exposure to the free ocean waters or not.

In species with stellate cells, there is always a definite number of rays to the *adult* cell, excepting among those that bud in the disks, and this number is some multiple of four or six, and usually of both. The characters of the cells, whether immersed or occupying a prominent calicle; and, *internally*, deep and open at bottom, or transversely septate, or spongy cellular, or solid,—are important; also the peculiarities of the lamellæ, whether entire or not, equal or irregular, exsert or included.

In transverse sections of the stellate cells, the number of rays, (when adult,) the diameter, and the character of the centre, and of the interstices, are generally good characteristics for species.

The corals of *Alcyonaria* never have rays to their cells or tubes; the *Madreporacea* have never more than *twelve* rays; the *Caryophyllacea* and *Astræacea* have always more than twelve; and the last order is distinguished by having the interval between the cells lamello-striate (see p. 344, III, 2) *internally*, with few exceptions, as well as *externally*.

This brief review of the characteristics of zoophytes, has prepared the way for an exposition of the classification into which the species naturally fall.

Art. XXXIV.—*Notices of Koordistan.—Hot Sulphur Spring—Manna—Mines of Lead—Sulphur and Orpiment—Rock Salt and Saline Springs—Ruins, &c., derived chiefly from the letters of Rev. A. H. Wright, M. D., of the Mission of the A. B. C. F. M., at Oroomiah,* Persia ;* communicated by Oliver P. Hubbard, M. D., Prof. Chem., &c., Dartmouth College.

The Nestorians of the mountains of Koordistan, which lie to the west, in the limits of Turkey, have recently suffered severely

* This Mission is situated among the Nestorians, at Oroomiah, in Persia, by the salt lake of the same name. This lake is about 1400 yards above the sea, about eighty-nine miles in length from north to south, and in breadth about thirty-two miles. The governor of this district is Yahyah Khan.

in two campaigns against them by Badr Khân Bey, chief of Buhtan, who resides near Jesireh, on the Tigris—which disturbances have rendered the passage of the mountains unsafe and even dangerous for all travellers.

B. K. Bey, however, needed medical advice, and made an urgent request, through his neighbor Noor Ali Khan, the Hakkary chief, residing at Julamerk, and directly through the Governor of Oroomiah, that Dr. Wright should make him a professional visit, assuring him of "every practicable means for his security on the journey."

Accordingly, on the 4th of May last, accompanied by Mr. Breath, of the Mission, two native assistants and a guide, Dr. Wright commenced his journey, and lodged at night in an encampment of Koords, by the roadside. The next day, the 5th, they came to the fort of Ali Aga, a Koordish chief, who resides on the frontiers of Koordistan, and who hospitably entertained them; and when they left on the following morning, he gave them a London thermometer. Having crossed a high range of mountains, they reached Hoshgan, a small Koordish village, on the 6th. The 7th being rainy, they rode but two hours to a place called "the Four Churches," and on the 8th, spent the night at Kermè. The next day, the 9th, about noon, they arrived at the castle of the chief, at Julamerk.

Here "they were detained thirteen days, it being reported that the mountains beyond were still covered with snow, and that it would be impossible to pass them for some time to come." The chief was "enlarging and ornamenting his castle, and as iron is dear in Koordistan, great quantities of the guns, daggers and other weapons taken in war from the Nestorians, were used up in making nails." They left Julamerk on the 21st of May, and soon ascended a high range of mountains lying west of Julamerk, and on reaching the summit, had an extensive view of the surrounding country. On the east and south, rose the lofty mountains of Diss, Jeloo, Tehoma and Tiyary; in the west, far in the distance, were the mountains of Buhtan; and on the north, lay a wild region, reaching to Lake Van, which is some 1800 yards above the sea.

In the course of the day, they passed through the districts of Sillah and Leewin. Next morning they ascended another mountain, (range,) the higher portions of which they found covered with snow, but so frozen on the surface as not seriously to impede them. In the forenoon, they passed a Nestorian village of fifteen houses, situated on a plain, surrounded by the mountains which contain the sources of the Khabour, a branch of the Tigris. From Julamerk to this point, the course had been "about west. They now turned to the south, taking the western bank of the Khabour."

Hot Sulphur Spring.—"On the 23d of May," says Dr. Wright, "just before noon, we came to a hot sulphur spring, where we stopped some hours. Though we had heard much of it on the way, as a natural curiosity, our expectations were more than realized. The water rushes out of a crevice in a high rock, which is a spur of a still higher mountain, in a bold, rapid current, sufficient to carry a grist mill of ordinary size, and after passing some twenty feet, the stream becomes a branch of the Khabour. Just as the water issues from the crevice, the rock projects above and beyond, in such a manner as to form a small apartment, quite sheltered from the wind; thus affording an unequalled hot bath in this wild region, so destitute of the ordinary comforts of life. The water is clear as crystal, and of a temperature of 105° Fah., and very remarkable for its quantity, purity and temperature. I have seen most of the Virginia springs, all of which appear quite insignificant in comparison with this. I have visited the baths in Constantinople, Erzeroom, Tabreez and Oroomiah, which are fitted up with every thing to please; but weary and worn as we were in crossing mountain heights and snow-capped peaks, it was a greater, an inexpressible luxury to throw ourselves into this beautiful water and bathe our aching limbs. We wished to carry away with us some of the water for the purpose of analysis, but as our loads were thrown down some precipitous bank every little while, breaking every thing that could be broken, we were not disposed to add to them.

"The place is much frequented by the people living in these parts, both Koords and Nestorians; and many a poor traveller, crossing these snowy regions in the winter, finds here a delightful shelter for the night, from the cold mountain blasts."

After leaving the spring, the road was exceedingly rough and precipitous; and on the 25th of May, they left the Khabour and travelled nearly west, and after crossing an elevated range of mountains, their course lay along the base of immense rocky palisades. On the 26th, the course was southwest; and a ride of seven hours on the 27th, over an uneven and barren country, brought them to Dergulè, the residence of Badr Khân Bey,—a small town of a few hundred houses, built of stone and mud, and twelve miles east of Jezireh. The castle of this chief stands near the village, on the brow of a hill, overlooking a small stream, which flows into the Tigris. The chief was about removing, on account of the heat, to more elevated and cooler regions, and Dr. Wright and Mr. Breath accompanied him in his migrations from place to place, during four weeks: the former was engaged professionally every day, more or less, among the sick in the Emir's family and retinue, and successfully introduced vaccination among them.

These gentlemen commenced their return to Oroomiah on June 24th, by an easier route, farther to the north, by Bashkallah, which they reached in six days travel, and on the 3d July, arrived at Oroomiah, after an absence of two months.

Dr. Wright thus speaks of the country:—

"*Physical Features.*—Our route to Dergulè, led us across central Koordistan, and through a region of almost unequalled interest, in a physical point of view. Mountains, valleys, precipices, gorges, rivers, &c., combined to form the most attractive scenery; and such was the variety of rock and minerals, that the geologist and mineralogist would find it a region of rare interest. No man devoted to natural science has ever been through these regions. Some twelve or fifteen years ago, Prof. Schultz, of a German University, made the attempt, with purely scientific objects in view. His motives were mistaken, and he was murdered by order of the Koordish chief of Julamerk. We have now formed such an acquaintance with that chief and others having power in the mountains, that I think we can ensure one a safe passage through any part of the country. The Emir, B. K. Bey, prides himself on being a man of '*one word*,' and pledged himself as our '*friend*.'"

The peculiarities of the different routes are thus referred to. Dr. W. says of his return route:—

"The country over which we passed was elevated and mountainous; but the mountains were not heaped up in regular ranges or chains, as on the Julamerk route; they seemed rather to have been thrown together in a confused manner, resembling the surface of the ocean, when lashed into commotion by contrary winds." "During the first day and part of the second, we passed over a district covered with a stunted growth of oak and gall-nut trees, &c., but from that time until we reached Salmas, we did not see trees or shrubbery of any kind. The mountains and hills were not barren, however, but covered with grass to their summits, affording a grazing district equal to any in the world. In the winter they are a waste, being enveloped in snow, and no dweller or traveller is ever seen among them." The flocks of sheep from the plains of Mesopotamia, are driven here by a gradual ascent, as the season advances in the spring, and retire before the early snows, from the summits to the champaign below, for winter quarters. Thousands of sheep, with their keepers, were seen on the hills at this time.

Dr. W. describes a substance he met with, under the name of *Manna*. We found "in one part of the mountains (probably on the return route) great quantities of a sweet substance, formed on the leaves of certain trees, generally the oak and gall-nut tree, and which is called *gezza* in Koordish, and *manna* in Syriac, and perhaps *honey-dew* in English. It forms on the leaves in such

abundance, that when they are dried and pounded, it comes off in scales, and is collected and used as an article of food. When melted and strained, in order to separate the crumbled leaves, it is very delicious, and is eaten by the people often in preference to honey. In the summer, it is collected in large quantity and put up for winter use. Often, as we were riding along among the trees loaded with it, we found it pleasant to break off the branches and lick the leaves, which were so coated with it that in a very few minutes our appetites were satisfied. There is a species of willow growing on the water courses in Persia, on which this article is sometimes found; but we have never seen it there in such abundance as in the Koordish mountains."

The term *manna* ordinarily refers to the well known product of several species of Fraxinus, "that grow spontaneously in Italy and Sicily, and very probably in all the oriental Mediterranean region," and which is used for medicinal purposes. Substances which resemble this in form, or taste, or mode of production, are also called by the same term, which, in every case, therefore needs defining. The *gezza* was observed in June, and from Dr. W.'s account, we infer it was a semi-fluid exudation upon the leaves of certain trees. This has been mentioned by writers in other parts of Asia; and as it differs so entirely from other forms of *manna*, which occur under peculiar circumstances, a few facts from various authors may here be cited.

Wellsted,* in his journey from Tór to Mount Sinai, September, 1836, "found in the Wádi Hibron, fifteen miles from the sea, and at an elevation of about two thousand feet, the tree which produces the *manna*. This remarkable substance is secreted by several trees, and in various countries in the East. In some parts of Persia, it is believed to be an insect secretion, and is collected from a shrub called *gavan*, about two feet high, bearing a striking resemblance to the broom. In the hilly district of Looristan, (southeast from Koordistan,) as in Mesopotamia, we find it on several species of oak, which there, however, are of more stunted growth than in England. From these, the manna is collected on cloths spread beneath them at night, and it then bears the form of large crystal drops of dew, such as we see on plants in England, in the early part of the morning. Burckhardt observes that at Erzrūm, a substance resembling manna in taste and consistence, distils from the tree which bears galls, and with the inhabitants of the country forms one of the principal articles of their food."

In the Horticulturist, No. 7, January, 1847, is an article translated from the Révue Horticole, from which we extract the following notice of what appears to be the same (or similar) thing with the *gezza*.

* Travels in Arabia, vol. ii, pp. 47, 48.

"Ehrenberg and Bové described the '*Manna Tamarisk*,' which is abundant throughout Arabia, and even found on Sinai, nine hundred feet above the sea. The women and children collect this, which flowed from the branches of these trees. The Arabs clarify the manna by dissolving it in warm water, and making a syrup, the taste of which is equal to that of the best honey."

Under the word "*manna*," in the Dict. Univ. d'Hist. Nat., Paris, 1846, is mentioned "a stunted, spinous shrub—Hedysarum alhagi, *Linn.*, Alhagi Maurorum, *Tourn.*—as growing in the deserts of Arabia and Persia, upon which is gathered a white, concrete juice, which is called *manna alhagi*. Olivier, on his return from Turkey, brought to France several pounds of this substance, which, according to Niebuhr, is used in Persia instead of sugar in pastry, &c."

"Mr. Lindley* has recently pointed out an oak, *Quercus mannifera*, from the leaves of which also drops a sweet substance, which seems to have been mentioned under the name *chelber*, by Olivier. This name, which is applied by the hordes of Korassan and Little Tartary, to a nutritious substance which falls on the ground, it is easy to see approaches very nearly to that of *Semljenoi-chleb*, by which name the nations of the Kirghiz designate the *Lecanora esculenta*."

"Several occurrences of what is called a fall of *manna*, are attributable to the accumulation of this Lichen, Lecanora esculenta. Aucher-eloi† observed it in Persia in layers of nearly four inches (0 *m.* ·12 to 0 *m.* ·13) in thickness. He sent specimens, with the following note, to France. 'In 1829, during the war between Persia and Russia, there was a great famine in Oroomiah, south-west of the Caspian. One day, during a violent wind, the surface of the country was covered by a lichen, which *fell from heaven*. The sheep immediately attacked and devoured it eagerly, which suggested to the inhabitants the idea of reducing it to flour and making bread of it, which was found to be good and nourishing. The country people affirm that they had never seen this lichen before nor after that time.'" "During the siege of Herat, (which is about eight hundred and seventy-six feet above the sea,) more recently the papers mentioned a hail of *manna*, which fell upon the city, and served as food for the inhabitants." "A rain of manna occurred April, 1846, in the district of Jenischehir—the government of Wilna—on the grounds of M. Tizenhauz, and formed a layer three or four inches in thickness. It was of a greyish-white color, rather hard, and irregular in form, inodorous and insipid."

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* Révue Hort., as already cited.

† Relat. d'un Voy. en Orient, vol. ii, p. 399.

"Pallas observed it in the mountainous, arid and calcareous portions of the great desert of Tartary. M. Eversham collected it in the steppe of the Kirghiz, to the north of the Caspian Sea, where it is called *semljenoi-chleb*. M. Ledebour has observed it in the same countries, but chiefly those which border on Altaï; and Bilezikdgi saw it also in Anatolia, in 1845. Dr. Léveillé gathered it in Crimea, and Dr. Guyon recently in Algeria."

"It is found in irregular shaped bodies, varying in size from that of a pin's head to a pea or small nut, and when seen in its proper sites, has never been found attached to any support whatever. An analysis of the Lecanora shows that there is no fecula in its composition."

Wellsted, p. 49, "learned from a Jewish Rabbi, that on his journey through the desert contiguous to Damascus, far removed from trees or vegetation of any kind, a substance was deposited, which, from his description, in appearance, size and flavor, accurately resembled the manna of the Scriptures. Similar testimony was derived from several Bedouins."

It may be remarked, in passing, that several writers have not hesitated to identify some of these species with the manna miraculously supplied to the Israelites, in the wilderness. They were obviously acquainted with manna of some kind, from the fact that they named the new substance from its resemblance to it. Dr. Wright describes, also,—

"*Mines of Lead, Sulphur and Orpiment*, which exist in the mountains, and are worked by the natives there. The lead mines are found mainly in the Nestorian country, where they are worked chiefly to furnish balls for rifles. *Sulphur* is found in many localities, and is obtained for the purpose of making powder. In many cases, a man makes what he wants for his own use, and may sell a little to his neighbors. The *Orpiment* mine is owned by the chief of the Hakkary Koords, Noor Ali Khan. It is worked extensively, and has been for many years. About twenty Koords are employed, day and night, in digging the ore and bringing it out to the surface. The ore occurs in veins, which run, in various directions, into the body of a high mountain. The mineral is exported to every part of Persia and Turkey, where it is largely used in making a composition with which Mussulmân's remove the hair growing on their bodies, when frequenting the baths; for hair is an abomination to them, except on the face, and a lock or two on the head. Orpiment is also used by them as a pigment." Mr. J. D. Dana informs me he has purchased specimens of orpiment in Smyrna, which were probably derived from this locality.

"*Salt and Saline Springs.*—There are some salt springs on the west side of the mountains, near the Tigris, which are very useful in furnishing salt, by solar evaporation of the water. Most

of the salt, used in Eastern Koordistan, however, is carried from the lake of Oroomiah, 'the saltest water in the world,' on the shore of which it is found in great abundance. Porter says of the lake, as seen from the hills on the east, that 'its waters now appeared of the deepest blue, and most singularly hemmed in by a broad belt of salt, looking at a distance like a violent surf.' 'In many places it lies more than a foot thick, and where the bed of the lake slopes gently from the land, the salt left by evaporation in summer often exceeds a breadth of three or four miles down to the verge of the waves.' '*Rock salt* is found in some localities in this vicinity, and is a very good article.' "*

After these mineralogical notices, Dr. Wright mentions some

Remarkable Ruins.—"We found in great numbers, scattered over the country, a mysterious species of ruins, which puzzled us extremely in endeavoring to satisfy our minds as to their history. They consisted of collections of stones, many of them very large, which were once built up in the form of a regular structure, usually oblong. We heard of some still standing, built up some ten or fifteen feet high, without door, window or roof. The Koords have the idea, as we learned upon inquiry, that they are the work of Deevs,† whom they regard as spiritual beings, who were engaged in a war with the human race, and who built these structures for their strongholds in the conflict. My companion, Mr. Breath, conjectures they may be the remains of the works of the Fire Worshippers, who formerly occupied these parts, though it is difficult to imagine what object they could have had in constructing them. On the plain of Oroomiah, there are numerous remains, which it is altogether probable are the relics of the ancient Fire Worshippers. The indications of their character are much more obvious than those of the mountains."

Art. XXXV.—*Caricography;* by Prof. C. Dewey, M. D.

(Appendix, continued from this volume, p. 173.)

No. 209. *C. oxylepis*, Torrey. Mon. N. Am. Cyp., p. 409.

Spicis 4–6 longo-cylindraceis sublaxifloris erectis exserte pedunculatis, inferioribus subremotis basi distantifloris, superiore inferne staminiferis; fructibus *tristigmaticis* oblongis utrinque acutis subtriquetris glabris ore vix bilobatis, squama ovata oblonga margine hyalina cuspidata paulo longioribus; culmis inferne foliatis.

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* V. Am. Jour., vol. xxxvii, p. 350, *et seq.*

† Sir R. K. Porter, in his Travels in Persia, describes a mound with massive marble structures upon it, in the plain of Morgaub, near Persepolis, called "the Court of the Deevs, or Devils," and in many places the temples of the Fire Worshippers.

Culm erect, slender, 15 inches high, with shortish leafy bracts; leaves flat, lanceolate, acute, striate, originating towards the root, and shorter than the culm, slightly pilose on the under side; spikes 4–6, erect, pedunculate, bracteate, lower ones sheathed and very loosely flowered at the lower part, the upper spike staminate below, with long and lanceolate staminate scales; stigmas three; fruit oblong, tapering to each end, smooth, subtriquetrous, dark brown, rather loose, orifice nearly entire; pistillate scales ovate, oblong cuspidate, white and membranous on the edges, shorter than the fruit; plant pale green.

Texas—*Torrey;* Florida—*Dr. A. W. Chapman*, author of the *List of Plants near Quincy, Florida;* Louisiana—*Dr. Hale.*

Related to *C. formosa* and *C. æstivalis*, though far different. Specimens from Florida and Louisiana are fine and beautiful.

No. 210. *C. Baltzellii*, Chapman. *List of Florida Plants*, 1845.

Spica staminifera unica perlongo-pedunculata, squamis oblongis obovatis obtusis vel subemarginatis brevimucronatis; spicis pistilliferis 3–4, oblongis erectis laxifloris subradicalis pedunculatis, suprema interdum apice staminifera; fructibus tristigmaticis oblongis obovatis obtusis triquetris brevi-rostratis ore integris subpubescentibus vel scabris nervosis, squamam similem staminiferæ subæquantibus; foliis radicalibus subpubescentibus.

Culm 6–10 inches high, slender, triquetrous, terminated by a cylindric and clubform staminate spike, as if supported by a nearly radical peduncle; leaves radical, flat, striate, lanceolate, much surpassing the culm, and slightly pubescent; pistillate spikes 3–4, subradical, pedunculate, approximate, cylindric, loosely flowered, the highest often continued into a short staminate spike; stigmas three; fruit oblong, obovate, obtuse, short rostrate, subscabrous, entire at the mouth, sometimes distinctly triquetrous, nerved; pistillate scale, like the staminate, oblong, obovate, obtuse or slightly emarginate, mucronate, and often slightly surpassing the fruit, deep reddish-brown on the edges, and green on the keel; whole plant rather light green.

Florida—*Chapman;* a singular and beautiful species, closely allied, as Dr. Chapman remarked, to *C. pedunculata.*

No. 211. *C. polymorpha*, Muh. Gram. Muh., p. 239.

Spicis staminiferis 1–2, raròque 3, oblongis cylindraceis erectis, superiore pedunculata, ceteris sessilibus; spicis pistilliferis 2, longo-cylindraceis erectis incluse pedunculatis bracteatis dnsifloris *tristigmaticis*, superiore apicem staminifera; fructibus ovatis acuminatis vix rostratis ore bifidis nervosis glabris, squama ovata fusca duplo longioribus; foliis lanceolatis inferne abbreviatis.

Culm 14–20 inches high, erect, with leafy bracts; leaves lanceolate, striate, shorter below and shorter than the culm; staminate spikes 1–3, erect, cylindric, often more than an inch long, with ovate and oblong short acute scales, upper one pedunculate; pistillate spikes 2, oblong, cylindric, closely jointed, erect, upper one often staminate at the apex, all with enclosed peduncles, upper nearly sessile; fruit ovate, acuminate, bilobate, scarcely rostrate, striate, longer than the ovate and tawny scale.

Penn.—*Muh.*;—New Jersey—*Torrey;* Florida—*Chapman.*

All the varieties noticed by Muhlenberg, have not been found by later botanists. Perhaps one of them is *C. Halseyana*, which is, however, too different in various respects. In *C. Halseyana*, the staminate scale is more obtuse, and the fruit is distictly rostrate, or more nearly ovate-globose, and continued into a distinct beak, two-toothed, much less glabrous, and the spikes less closely flowered. All the Carices in Muhlenberg's Gram., are ascertained.

No. 212. *C. turgescens*, Tor. Mon. Am. Cyp., p. 419.

Spica staminifera solitaria oblonga erecta pedunculata; spicis pistilliferis 2–3, ovatis paucifloris erectis subsessilibus folio-bracteatis *tristigmaticis*, infima nunc remota nunc subapproximata exserte pedunculata; fructibus ovatis inflatis conico-longo-rostratis striatis divergentibus ore bifidis, squama ovata magis duplo longioribus.

Culm 15–30 inches high, erect, with long and leafy bracts; leaves linear-lanceolate, striate, shorter towards the root, and all surpassed by the culm; staminate spike long cylindric, pedunculate, and small bracteate; pistillate spikes 2–3, ovate, few flowered, erect, mostly sessile, except the lowest, which is often remote and long pedunculate; stigmas three; fruit ovate, inflated, long-conic, and thus rostrate, two-toothed, with prominent or raised striæ, diverging, glabrous, more than twice longer than the ovate scale; light green.

This is *C. folliculata*, Elliott, (not of Lin.,) found in South Carolina; also in Louisiana—*Torrey;* Florida—*Chapman.*

Related to *C. folliculata*, Lin., and *C. intumescens*, Rudge, the *C. folliculata*, Schk. Dr. Torrey saw the difference and properly gave the species a name. Its fruit is far more inflated than that of *C. folliculata*, L., and far more tapering and conic than that of *C. intumescens*, Rudge.

Art. XXXVI.—*On a New Metal, Pelopium, contained in the Bavarian Tantalite; by* Prof. H. Rose.*

In a former paper,† on the composition of the so-called tantalic acid which occurs in the columbite of Bodenmais in Bavaria, I showed that it consisted of two acids, one of which differs so decidedly from all known metallic oxyds, that I did not hesitate to regard it as the oxyd of a new metal, which I named niobium. I did not then enter into a description of the second acid, which occurs in company with the niobic acid, but merely observed that it possessed great similarity to the tantalic acid procured from the Finland tantalites.

The separation of the two acids according to the method I formerly described, was exceedingly troublesome and tedious. After I had suspected a peculiar substance in the so-called tantalic acid from columbite, and had vainly attempted in various ways to isolate it, I succeeded in effecting this only approximatively on converting the acid into chlorid, by mixing it with charcoal and passing a current of chlorine over the heated mixture. I obtained a yellow, readily fusible and very volatile chlorid, and a white, infusible, less volatile chlorid. Both were converted by water into metallic acids, which were not dissolved by the hydrochloric acid formed, but separated on boiling, and could easily be freed by washing with water from every trace of acid; but when the acid from the white infusible chlorid, after I had separated it as well as possible from the yellow one, was again mixed with charcoal, and treated with chlorine, I constantly obtained yellow and white chlorid; less, it is true, of the first than when the mixture of the two acids as they occur in the mineral was employed; but even when the operation was very frequently repeated with the acid from the white chlorid, it was not possible to obtain by this method a pure white chlorid free from yellow. I observed, however, that the white chlorid was only partially sublimed. When it was separated as much as possible from the yellow chlorid, and by sublimation also from a white non-volatile residue, it at last afforded an acid, which, on treatment with charcoal and chlorine, yielded a tolerably pure, white, wholly volatile chlorid, the chlorid of niobium. The white fixed residue yielded with charcoal and chlorine a large quantity of yellow chlorid; and after removing this by sublimation, again left a white non-volatile residue, which, on being again subjected to a similar treatment, afforded the same products.

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* Ueber ein zweites im Tantalit, (Columbit,) von Baiern enthaltenes neues Metall; von Heinrich Rose. Poggend. Annal.; cited from Chem. Gazette, September 15, 1846.

† Poggend. Annal. Bd. 63, S. 317.

On comparing this behavior of the yellow chlorid with that observed on treating a mixture of pure tantalic acid and charcoal with chlorine, I obtained a perfectly similar yellow chlorid and a white non-volatile residue; but the quantity was far smaller, and its production could be entirely avoided, if, in the preparation of the chlorid of tantalium, every trace of humidity and atmospheric air had been carefully excluded. Moreover, the sublimed yellow chlorid from the Bavarian mineral, very much resembled the chlorid of tantalium. This similarity likewise extended to the acids prepared from the two chlorids; they behaved so much alike, that it was only after long-continued investigation that properties were discovered by which they might be separated.

In the preparation of chlorid of tantalium from the tantalic acid from the Finland tantalite, and especially in that of the yellow chlorid from the Bavarian mineral, I frequently obtained considerable quantities of a red chlorid, which was still more volatile than the yellow one, and proved on examination to be the chlorid of tungsten. When the chlorids are exposed for some time to the air, the tungsten can be removed by digestion with ammonia, as soluble tungstate of ammonia.

Sometimes chlorid of tin and chlorid of titanium were obtained in preparing the chlorid; they could be readily distinguished, by their fluid state of aggregation, from the other chlorids.

The formation of the chlorids of tungsten and tin appears remarkable, inasmuch as the acids from which the chlorids were prepared had been kept in a moist condition for a long time in contact with sulphuret of ammonium. I draw especial attention to this circumstance, because, unless perfectly freed from these impurities, the chlorids and the acids prepared from them are obtained with very different properties.

The yellow chlorid from the Bavarian mineral differs, therefore, principally from the chlorid of tantalium by its leaving a white non-volatile residue on its production, or rather on its volatilization, at a high temperature. This residue consists principally of the acid which may be obtained from the yellow chlorid by decompesition with water.

In the preparation of the yellow chlorid from the columbite of Bodenmais, there is formed along with it an oxychlorid, which is decomposed by heat into chlorid and acid, just like the tungstate of the chlorid of tungsten. The formation of the oxychlorid can be prevented by placing a long layer of charcoal in the anterior portion of the glass tube, in which the mixture of acid and charcoal is to be treated with chlorine. While the chlorine is passing through the tube, this charcoal is first raised to a strong red heat, and then the mixture.

The acid of the yellow chlorid from the Bodenmais mineral, which is contained in it along with the niobic acid, I have named

Pelopic acid, and the metal *Pelopium*, from Pelops, the son of Tantalus, and the brother of Niobe; to point out, at the same time, by this name, not only its simultaneous occurrence with the oxyd of niobium, but more particularly the very great resemblance of pelopic acid to the tantalic acid from the Finland tantalites. This similarity is indeed more perfect than exists between the combinations of any other two simple metals; it is so great, that it was only after a long-continued and most minute investigation that I could decide upon publishing the results I had obtained. The combinations of niobium are, on the contrary, very different from those of pelopium or tantalium.

I will here describe the most important properties by which the compounds of tantalium differ from the corresponding compounds of pelopium, and at the same time enumerate those of niobium.

In its properties, pelopic acid is intermediate between tantalic and niobic acids, just as strontia is between baryta and lime. And in the same way as we are able to explain many properties of strontia, by assuming it to be a mixture of the two last-mentioned earths, we are able to determine *à priori* most of the properties of pelopic acid, by admitting it to be a mixture of a large proportion of tantalic acid, with a small quantity of niobic acid; and as was the case with bromine, which, on its discovery, was considered to be a combination of chlorine and iodine, I myself was long of opinion that the pelopic acid was nothing more than tantalic acid, still contaminated by a certain quantity of niobic acid, which I had not succeeded in separating. It was only by an uninterrupted investigation of this subject for several years that I became convinced of the distinctness of pelopic acid.

The chlorids of the three metals dissolve in cold concentrated sulphuric acid without any evolution of heat, but with disengagement of hydrochloric acid; but if the solution of the chlorid of tantalium and pelopium is boiled, it solidifies to a jelly. Water then does not dissolve any of the tantalic acid, but a large quantity of the pelopic acid. The solution of the chlorid of niobium by sulphuric acid is not rendered turbid by boiling; it even remains clear on dilution with water, but if it be now boiled, the whole of the niobic acid is precipitated from the solution.

Chlorid of tantalium dissolves in hydrochloric acid in the cold to a turbid liquid, which after some length of time forms an opaline jelly, from which water both cold and boiling dissolve only traces of tantalic acid.—But if chlorid of tantalium is treated with boiling hydrochloric acid, it does not dissolve entirely, and on cooling it does not form a jelly, but water now dissolves the whole of it to an opaline liquid, which is not rendered more turbid by boiling. Sulphuric acid produces in it, after some time, a voluminous precipitate even in the cold. The chlorid of pelopium behaves in a similar manner, except that sulphuric acid

does not produce a precipitate in the cold, in the solution obtained by boiling and diluted with water, but only on boiling. Chlorid of niobium does not dissolve in cold hydrochloric acid, and scarcely anything is dissolved on the addition of water: when, however, chlorid of niobium is boiled with hydrochloric acid, though not dissolving at first, on diluting with water the whole dissolves, and the niobic acid is not even precipitated from the solution by boiling. When sulphuric acid is added, a turbidness results even in the cold, and the whole of the niobic acid is precipitated by boiling. On the other hand, when but a small quantity of hydrochloric acid is placed in contact with the hydrates of the acids, the result is quite a different one. The same is the case when the chlorids of the three metals are treated with much water. The niobic acid is then completely separated on boiling from the chlorid of niobium, and also the pelopic acid from the chlorid of pelopium; but tantalic acid does not separate quite so completely from the chlorid of tantalium.

Chlorid of tantalium, heated with a solution of hydrate of potash, is partly dissolved; but a solution of carbonate of potash does not dissolve any tantalic acid even on boiling. Chlorid of pelopium is dissolved in large quantity by a solution of caustic potash, and even carbonate of potash dissolves it in tolerable abundance on boiling. Chlorid of niobium is dissolved even in the cold by a solution of potash, and also by boiling in a solution of carbonate of potash.

Tantalic acid remains white on being heated to redness; pelopic acid is rendered slightly yellowish; niobic acid, dark yellow. On cooling, both again become as white as before ignition.

All three acids exhibit, when their hydrates are heated very strongly, the phenomenon of phosphorescence. This, however, is not the case when the compounds with sulphuric acid are treated with ammonia, and then heated to redness.

Tantalic acid, exposed in a current of hydrogen to a strong red heat, remains white; pelopic and niobic acids become black; but the reduction which these acids undergo is quite inconsiderable, for very doubtful traces of water are perceptible, and the blackened acids quickly become white when heated with access of air, without experiencing any perceptible increase in weight. When tantalic acid is heated to redness in a current of gaseous ammonia by a brisk charcoal fire, it is turned gray, with the formation of but slight traces of water. Pelopic and niobic acids become black, and are reduced, with the production of a considerable quantity of water.

When tantalic acid is heated in a brisk charcoal fire, and sulphuretted hydrogen gas passed over it, it becomes slightly gray, but no trace of water is perceptible. Pelopic and niobic acids are converted by the same treatment slowly but entirely into sulphurets, with formation of water and separation of sulphur.

Metallic pelopium can be prepared from the chlorid by treatment with ammonia, in the same way as the metals from the chlorid of tantalium and chlorid of niobium. It has the greatest resemblance to tantalium.

When the ignited acids, which are insoluble in almost all reagents in the moist way, are fused in a silver crucible with hydrate of potash, they are dissolved. The fused mass is soluble in water. Hydrate of soda behaves in a different manner. When the ignited acids are melted with it, the fused masses obtained are not clear; but an insoluble sediment is formed, which does not dissolve in any excess of the alkali. If the fused mass be treated with a moderate quantity of water, the excess of soda is removed, and a white insoluble mass remains. If, after removing the free soda, a large portion of water be poured over the insoluble mass, it dissolves, and most completely when niobic acid has been employed.

The insolubility of the three acids in excess of soda, while the potash compounds are soluble in excess of potash, essentially characterizes them. In this they differ from similar acids, especially from tungstic acid. When the solutions of the soda salts are mixed with concentrated solutions of hydrate of soda, they immediately become turbid; if the mixture be made very slowly and carefully, all three soda salts may be obtained in crystals, which are deposited on the sides of the vessel. But crystals only of the niobate of soda can be easily obtained of any size. I succeeded in obtaining them half an inch and more in size, but in general they are much smaller. They are sparingly soluble in cold water, more readily soluble in hot; the solution may be boiled without becoming turbid; it can be evaporated, and the niobate of soda deprived of its water of crystallization without being decomposed. The salt is only rendered insoluble in water by being heated to redness.

The pelopate, and especially the tantalate of soda, are less stable; when their solutions are boiled, an insoluble white precipitate separates, which is an acid salt of soda.

When the niobate of soda is exposed to a red heat, and a current of dry sulphuretted hydrogen passed over it, a dark black crystalline mass is obtained, from which water removes hydrosulphated sulphuret of sodium, while crystalline sulphuret of niobium remains undissolved.

When pelopate of soda is treated in the same manner, there is no sulphosalt formed, but only sulphuret of pelopium. The tantalate of soda remains white on treatment with sulphuretted hydrogen, but its soda is converted into sulphuret of hydrogen and sodium.

When niobic acid is fused with an excess of carbonate of soda until the fused mass no longer decreases in weight, the amount

of oxygen in the expelled carbonic acid is twice that in the niobic acid employed. The results obtained on fusing pelopic and tantalic acids with carbonate of soda did not agree. By long-continued fusion of tantalic acid with carbonate of soda, so much carbonic acid is expelled that its amount of oxygen was equal to that of the tantalic acid employed, and finally exceeded it. But nevertheless this basic salt does not dissolve undecomposed in water, but leaves a considerable residue of acid tantalate of soda. Something similar takes place with pelopic acid, only the basic pelopate of soda formed dissolves entirely in water.

When the three acids are fused with carbonate of potash, they exhibit similar properties; but the potash salts are as soluble in the excess of carbonate of potash as in hydrate of potash. In this way we obtain compounds which are soluble in water and crystallize; but they contain carbonate of potash, which cannot be separated in any manner.

The combinations of tantalic acid with the alkalies, are characterized by their passing on all occasions into insoluble acid salts, especially on boiling and evaporating their solutions. The solutions of the alkaline pelopates exhibit this property in a far less degree, those of the niobates not at all. Insoluble acid niobates of potash or soda can only be produced by not fusing the acid a sufficient time with the carbonates.

Tantalic acid is soon and entirely precipitated from its alkaline solutions by carbonic acid as an acid salt; the same is the case with pelopic acid, but with greater difficulty and far more slowly. It is owing to this that the neutral solution of tantalite of soda becomes turbid even by exposure to the air, while that of the pelopate of soda does not become turbid even after long exposure, which is characteristic of it. Carbonic acid produces a precipitate in the solution of alkaline niobate only after a considerable length of time, which, however, is again dissolved by much water.

When the solutions of the alkaline tantalates and pelopates are treated with an excess of hydrochloric acid, the eliminated acids dissolve to faintly opaline liquids. Sulphuric acid produces in these solutions precipitates, and separates the acids on boiling; however, only the pelopic acid entirely, and but partly the tantalic acid. Hydrochloric acid precipitates the acid from the solutions of the alkaline niobates in the cold, and still more so on boiling; an excess of hydrochloric acid merely dissolves slight traces. This behavior is interesting, since we have seen that under other circumstances niobic acid may be wholly soluble in hydrochloric acid. Sulphuric acid precipitates niobic acid from its alkaline solutions even in the cold.

From the solutions of the alkaline tantalates the acid is entirely precipitated, without the assistance of heat, by chlorid of ammonium, pelopic acid less perfectly, and niobic acid still less.

When the solutions of the alkaline tantalates are rendered acid with hydrochloric or sulphuric acid, a pale yellow precipitate is produced in them by tincture of galls. An orange-yellow precipitate is formed, under similar circumstances, in solutions of the pelopates, and a dark orange-red in those of the niobates.

Ferrocyanid of potassium produces in solutions of the tantalates of the alkalies, when they have been rendered slightly acid, a yellow precipitate; in those of the pelopates, a brownish-red; and in those of the niobates, a red one.

When the three acids are fused with bisulphate of potash, they dissolve in it. Niobic acid alone solidifies with it to a crystalline mass. Water removes sulphate of potash from the fused masses, and leaves compounds of sulphuric acid with the metallic acids, from which, however, the sulphuric acid can be removed by very long treatment with water.

When hydrochloric or sulphuric acid is added to the solution of the niobate of potash or soda, and then a bar of zinc immersed in it, the separated niobic acid soon assumes a very beautiful pure blue color. It gradually becomes dirtier, and finally brown. The blue color is produced, in the solutions of the alkaline pelopates, only on the addition of sulphuric acid; but not even then is a blue color produced in the alkaline tantalates, which, however, takes place when the solution of the chlorid of tantalium in sulphuric acid is treated with water and zinc.

Tantalic acid yields before the blowpipe, with the fluxes, colorless beads, even in the inner flame; pelopic acid gives with the microcosmic salt in the outer flame a colorless, in the inner one a brown bead. Niobic acid colors the microcosmic salt in the inner flame of a beautiful blue; the bead can be easily blown colorless in the outer flame.

These are the most important differences between pelopic acid and tantalic acid on the one hand, and niobic acid on the other. To ascertain accurately the behavior of these acids and their combinations, is a most difficult task, as all three acids frequently exhibit highly anomalous properties. We have seen, for instance, that the niobic acid is readily dissolved, under certain circumstances, by hydrochloric acid, when separated from its combinations, while under not very dissimilar circumstances it is almost entirely precipitated by it. This is owing to the acid assuming different isomeric modifications.

The three acids resemble in this respect silicic acid, the behavior of which towards reagents is frequently remarkable, and only excites less surprise from our having been long acquainted with this acid, and its properties having been thoroughly examined.

This tendency of the three acids to assume different isomeric modifications is connected with the great variability which they

exhibit with respect to their specific gravity. My experiments on this subject have led me to the most unexpected results; although I have not terminated my investigations, I will nevertheless communicate at present some of the most important.

Some time ago I drew attention to the fact, that in the artificially prepared titanic acid the specific gravity gradually increases by long-continued ignition, until it attains that of rutile. In the same way the modifications of titanic acid which occur in nature, anatase and Brookite, may be converted by continued ignition into rutile. I thought that the publication of these facts would have induced chemists to examine the specific gravity of other oxyds at different temperatures, since these changes have an important influence on the atomic volume. This, however, has not happened, with the exception of a very interesting investigation of Count Schafgotsch, on the specific gravity of silicic acid, in which he has shown that opal, before heating to redness, has so low a specific gravity, that it floats on oil of vitriol; but that the specific gravity is so increased by heating to redness, that it equals that of chemically prepared silicic acid (2·2), but which is still considerably lighter than quartz and rock-crystal (2·6).

The changes which the three metallic acids under consideration experience by heating to redness are far more remarkable. When the hydrate of pelopic acid is deprived of its water by a gentle red heat over a spirit-lamp, just sufficient to produce the phenomenon of incandescence, and then exposed to a strong red heat in a charcoal fire, its specific gravity is considerably increased. If we examine the ignited acid under the microscope, we see that it consists for the greater part, of amorphous granules, in which some small crystals are perceptible. The ignited acid was then exposed to the most intense, and at the same time continuous heat, that a platinum crucible is capable of bearing, that of the porcelain furnace of the Berlin Royal manufactory. The acid was not melted by it, but was converted into a coarse sandy powder, which, examined under the microscope, consisted of perfect crystals. The specific gravity of the acid, however, was thereby considerably diminished; curious enough, it had become still lower than that which the acid possessed after the hydrate had been exposed to a gentle heat over a spirit-lamp, in order to expel its water.

On repeating this experiment, the specific gravity of the crystallized acid, which had been ignited in the porcelain furnace, was found to be constant, while by no other temperature could the acid be brought to a constant specific gravity.

These experiments are in so far remarkable as they prove precisely the contrary of what has hitherto been frequently admitted. Crystalline bodies, such as idocrase, epidote, and garnet, fuse at a high temperature, become amorphous, but of lower specific

gravity. It is evident that what applies to these substances cannot be advanced as a general rule.

Niobic acid has a far lower specific gravity than pelopic acid. It exhibits a similar behavior. The acid, exposed to the temperature of the porcelain furnace, appears under the microscope perfectly crystalline.

Tantalic acid behaves very different from the other two acids. It is the heaviest of all, and, by heating to redness in a charcoal fire, increases considerably in specific gravity, from 7·0 or 7·1 to 8·2. In the fire of the porcelain furnace it is likewise converted into a coarse powder, but which does not appear distinctly crystalline under the microscope. Its specific gravity is thereby only slightly lessened.

In all these experiments no alteration in the absolute weight was perceptible.

ART. XXXVII.—*Termination of the Palæozoic Period, and Commencement of the Mesozoic;* by D. D. OWEN, M. D.

SOME of the most distinguished and experienced geologists seem, from their recent publications, disposed to include the Permian system, in the Palæozoic division of the fossiliferous strata, regarding it as the terminating group of that period. Their arguments in support of this view, are—

The corals of this system are considered to have a palæozoic type.

From ten to thirty species* of brachiopodous mollusca are common to the Carboniferous and Permian systems.

The genera *Productus* and *Spirifer* are continued into it.

The *Chonetes sarcinulata* is common to the Silurian, Devonian and Carboniferous strata, and penetrates, according to M. de Verneuil, into the gypsum and marl deposits of Bakhmout, which are believed to belong to the Permian system.

The analogy which exists between the plants of the Permian and those of the Carboniferous system.

In estimating the value of the above arguments, the following facts must not be overlooked.

"Of all the corals of the Permian system which have come under the observation of Lonsdale, he has not yet detected one species† that is identical with any found in the inferior systems;‡ and the only corals which occur in profusion, pertain to genera

* The tables only show nine species.

† The table gives *Fenestella antiqua* (*Gorgonia antiqua*, Goldf.) as common to the Permian, Devonian and Silurian systems; and *Fenestella dubia*.

‡ See note Sur les equivalents du system Permien, par M. de Verneuil, p. 8.

analogous in structure to the *Fenestella*, *Retepora* and *Gorgonia*. But these reticulated corallines are by no means confined to the palæozoic strata. Six species of *Retepora* are given by Goldfuss, as occurring in the cretaceous system of Maestricht, and two species in particular, viz: *R. fenestrata*, Goldf., and *R. vibicata*, Goldf., are remarkably analogous in structure to forms occurring in the Silurian and Devonian rocks, whilst the genus *Gorgonia* is still living in the ocean.

As yet but one single species has been established as common to the Silurian, Devonian, Carboniferous and Permian systems, viz: *Chonetes sarcinulata*, (*O. striatella*, Dal. *L. lata*, v. B.;) since the *Spirifer hystericus* is given in the tables as only problematical in the Permian system, and but one, besides the preceding, is common to the Permian and Devonian, viz: *Terebratula concentrica*.

The only other four species of brachiopods noted in the table above referred to, *not peculiar* to the Permian system, are—*Lingula mytiloides*, *Productus Cancrini*, *Spirifer cristatus*, *Terebratula Rossyi*. These are given as common to the Permian and Carboniferous systems.

It appears from the above, that the force of the argument in favor of placing the Permian system in the palæozoic period, proves chiefly an analogy between it and the Carboniferous system; for when we examine the evidence to show that the Devonian and Silurian systems belong to the same era, the proof is feeble, resting on but two instances of specific identity.

Reflecting on the above, and other facts which are about to be enumerated, I have been led to differ from the writers alluded to, or at least to doubt the propriety of a classification which throws the Permian and Carboniferous systems into the palæozoic period, high as the authority is from which the proposed classification emanated.

Before proceeding to give the arguments in favor of a different arrangement, let us see what ought to be our most important guide in determining the great division of rocks.

These divisions are, in one sense, arbitrary. Geological eras cannot be considered as separated by abrupt transitions: where the series are complete, there is a blending of one system into the other; especially a gradual dying off of orders, genera and species of fossil forms, rendering it difficult, sometimes impossible, to draw broad and well defined lines of separation. Still, taken as a whole, the best guides in defining their limits seem to be the evidence of a more or less complete change in the physical condition of our planet; the termination of one great class of phenomena and the beginning of another; the extinction of races and the development of new tribes; the proofs of the elevation and disruption of formations and the unconformability of stratifica-

tion; the evidence of a change in the relative position of land and sea.

Let us consider, then, in the first place, what is the evidence of such phenomena about the termination of the Permian system and the commencement of the Triassic.

In every country where these systems exist, so far from there being any evidence of disturbance or unconformability about the termination of the one and the beginning of the other, there is so complete a blending of adjacent strata, that it is only since the geological examination of Russia, by Murchison, Verneuil and Keyserling, that the Permian beds have been distinguished from the variegated marls and sandstones of the trias; indeed, even at this day it is hardly decided where the dividing line ought to be drawn.

It is true that a few genera of Brachiopoda and Gasteropoda, which occur in the Silurian and Devonian systems, are continued into the Permian, and here, perhaps, become extinct. But is this to be considered of as much importance as the extinction of a whole tribe? Is it of as much moment as the commencement of a luxuriant tropical vegetation? Is it to be compared to the apparent coming in of a new order of terrestrial animals?

If we except the small and rather insignificant genera of *Griffithedes* and *Phillipsia*, which occur in the limestone on which the coal measures rest, does it not appear that the entire race of trilobites becomes extinct at the termination of the Devonian period. Just at the time when this remarkable family of crustaceans passes away, have we not the strongest proof of a most extensive accession of dry land in the luxuriant and extra-tropical vegetation of the carboniferous epoch. Before this period, with one or two rare examples, no trace of land plants has been discovered. If, during the Silurian and Devonian periods, a suitable climate had prevailed, capable of supporting a terrestrial vegetation, and dry land had existed in a proper position, we should certainly, long ere this, have obtained marks of its presence.

In the Permian system, there have been discovered in Europe, at least twelve species of Sauroid reptiles, an order of animals which may be regarded as singularly characteristic of the mesozoic period, and imprinting, more than any other race, a peculiar type to the mesozoic fauna. If the footmarks observed by Dr. King, in the coal measures of Pennsylvania, should prove, as at present suggested, to be referable to some reptile, then the commencement of air-breathing reptiles is just coeval with the grand carboniferous flora.

These are certainly strong arguments in favor of placing, not only the Permian, but also the Carboniferous group in the mesozoic period, and terminating the palæozoic division with the commencement of the coal measures.

The previous remark with regard to the blending of adjacent strata, and the prevalence of some characteristics of one era in the nearest members of the next, applies, to a certain extent, to the systems in question. Indeed, the Carboniferous and Permian systems may be regarded as transition groups, connecting the palæozoic and mesozoic periods. But, take them as a whole, if we are to include them in one or the other of these periods, there is, to my mind, far more reason for grouping them with the mesozoic than with the palæozoic deposits.

Besides the arguments just brought forward in support of the above classification, I invite attention to the following.

Hardly a vestige exists in the Permian system, of the numerous Cephalopods so conspicuous in the Silurian and Devonian. The only specimens of this order of mollusca recorded, are: *Nautilus Freislebeni*, a nondescript *Nautilus*, and a problematical fragment of an *Ammonite*. So far, therefore, as the Cephalopoda are concerned, analogy connects the Permian species with the mesozoic strata.

Only a single fossil fish is known common to the Permian and inferior systems, and that not lower than the Carboniferous; i. e. *Palæoniscus Freislebeni*, which occurs both in the Permian and Carboniferous systems, but not in the Devonian and Silurian.

But three Gasteropoda are cited as common to the Permian and inferior systems, and two of these are problematical; i. e. *Loronema Urii* and *L. rugifera;* the former, *perhaps*, common to the Permian and Devonian systems. The third, the *Pleurotomaria carinata*, is given as common to the Permian and Carboniferous systems.

Only one of the Monomyaria, i. e. *Avicula antiqua*, is common to the Permian and inferior systems, being found also in the Carboniferous.

All the species of Dimyaria are peculiar to the Permian. On the whole, therefore, very few even of the mollusca are common to the Permian, Devonian and Silurian; and when we recollect that this class of animals is capable of surviving very great vicissitudes, it cannot be considered extraordinary that a few may have escaped and outlived even a great change of temperature, or some sudden catastrophe.

In addition to the above arguments in support of the views here taken of the classification of rocks, the reader may be reminded that the Permian system of Russia, according to M. de Verneuil, rests unconformably on the upturned edges of the Carboniferous group, whilst a similar want of conformity ("*pareille discordante*") is very rare between the Permian and Triassic.

Art. XXXVIII.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by E. N. Horsford.

(Read before the Albany Institute, September, 1846.*)

As there are laws in physics, whose evolution, carefully traced, would constitute a general history of this department of science, so there are bodies in chemistry, whose career, if we may employ such an expression, accurately followed out, would acquaint us with the prominent periods through which this science has passed. The history of *sulphuric acid*, for example, may almost be said to be the history of *technical* chemistry, as that of *hydrosulphuric acid* and *ammonia* is of *analytical;* or, as that of *oxygen* is of *theoretical* chemistry.

Among the bodies belonging to organic chemistry, perhaps no one presents itself, whose history, fairly exhibited from the time of its discovery down to this date, contains more obvious and lasting impressions of the periods through which this branch of chemical science has passed, than the sugar of gelatine. It bears the stamp of a period when an organic analysis had scarcely been made; of a time when the substance was not obtained pure; then of a time when, from the perfection of methods and apparatus, analyses enjoyed the whole confidence of the chemist, and it was only necessary that formulæ should coincide with them, in order to their being considered correct; and finally, of a time in which the relations to other substances came in to share in the solution of the problem of the constitution of an organic body. These circumstances may justify a glance at the history of this interesting body.

Braconnot,† in 1820, by treating isinglass with sulphuric acid, obtained a body of sweet taste, ready solubility in water, difficult solubility in alcohol, capable of uniting with nitric acid, and in this state of combination uniting with alkalies and alkaline earths; to which substance he gave the name of sugar of gelatine, (*sucre de gelatine.*)

Boussingault,‡ to whom we are indebted for the first analysis of this body, gave it the formula $C_{12}H_{31}N_6O_{11}$, which, expressed in equivalents, is $C_{12}H_{15\frac{1}{2}}N_3O_{11}$.

From this body he obtained a crystallizable compound, with the protoxyd of lead, which, upon analysis, yielded the formula $C_{12}H_{13\frac{1}{2}}N_3O_7+3PbO$. Three atoms of protoxyd of lead had taken the place of two atoms of water.

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* Published in Liebig and Wöhler's Annalen, 1846; and translated for this Journal by the author.

† Annal. de Chim. et de Phys., T. xiii, p. 113.

‡ L'Institut, No. 245. Phar. Cent. Blatt, No. 50, 1838.

If this be regarded neutral, Boussingault remarks, the body without water would be $C_4 H_{4\frac{1}{2}} NO_3$.

The investigation undertaken at this period (1838) was resumed in 1840, '41,* when, from the same chemist, a new formula, obviously based upon a conscientious trust in the results of analysis, was produced.

Meanwhile, Mulder† had obtained the same body with Leucin, by treating glue with caustic potash. His analysis led him to the formula $C_8 H_9 N_2 O_7$. With protoxyd of lead it lost two atoms of water. Its composition would then have been $C_8 H_7 N_2 O_5 + 2HO$, the two atoms of water being replaceable by two atoms of protoxyd of lead. This formula differs from that of Boussingault, chiefly in that it is about two-thirds as large. In that of Boussingault, an equal loss of water was, however, replaced by three atoms of protoxyd of lead, instead of two.

With the gelatine-sugar-nitric acid, (*acide-nitro-saccharique; leim-zucker-salpetersaure,*) Mulder obtained a compound with baryta, of unusual constitution, which he expressed by the following formula—

$$(BaO, C_3 H_7 N_2 O_5) + 2(BaO, NO_5).$$

His formula for gelatine-sugar-nitric acid, is

$$C_8 H_{11} N_4 O_{19} = C_8 H_9 N_2 O_7 + 2 NO_5 + 2 HO,$$

while that of Boussingault, for this compound, was

$$C_4 H_{6\frac{1}{2}} N_2 O_{10} = C_4 H_{4\frac{1}{2}} NO_3 + NO_5 + 2 HO.$$

These differ from each other in the relative and absolute quantities of hydrogen and oxygen, and yet not so widely but that the want of correspondence might be attributed to slight impurity of substance.

Boussingault analyzed a compound of this acid with oxyd of copper, of the following constitution:—

$$C_4 H_{6\frac{1}{2}} N_2 O_{10} + 2 CuO =$$
$$(C_4 H_{4\frac{1}{2}} NO_3, NO_5) + (2 CuO, HO).$$

At a temperature of 165° C., [329° F.] this compound lost 17·71 per cent. of water, leaving

$$C_4 H_{2\frac{1}{2}} NO, NO_5 + 2 CuO.$$

Deducting the two atoms of oxide of copper, there remains a body— $C_4 H_{2\frac{1}{2}} NO$.

In this condition of the question, as to the constitution of glycocoll, the investigation was resumed by Boussingault. He analyzed the body itself, and several most interesting compounds of it with oxyds of copper, lead and silver, nitric acid and nitrates of metallic oxyds. From these he derived the formula

$$C_{16} H_{15} N_4 O_{11} + 3 HO,$$

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* Ann. de Chim. et de Phys., 3d Ser., T. i, p. 257–270.
† Nat. en Scheik. archief, 1838, p. 146.

in which the three atoms of water were replaced with four atoms of metallic oxyd.

The gelatine-sugar-nitric acid he found to be

$$C_{16}H_{15}N_4O_{11},4NO_5+9HO,$$

and its compounds with bases to be

$$C_{16}H_{15}N_4O_{11}+4NO_5+4(8)MO+2aq.$$

This exceedingly complicated formula, and its high atomic weight, together with the fact that the several formulæ for gelatine sugar, enumerated above, though differing absolutely from each other, are nevertheless but slight modifications from once, twice, three and four times the following formula,

$$C_4H_4NO_3,$$

led naturally to the conclusion that the differences might be attributed partly to the impurity of the substances analyzed, and partly to the imperfect atomic weights at that time in use.

Beyond the description and analysis of the body itself, and the few salts above enumerated, gelatine sugar had met with no detailed examinations. These considerations gave occasion to the investigation which follows. It is scarcely necessary to add to the statement of its having been conducted at Giessen, that the counsel and coöperation there enjoyed, have united with the recollections of this labor, some of the most grateful memories of a life.

Formula of Glycocoll.

Finding it impossible to obtain as large a per-centage of carbon by the combustion of gelatine sugar, either in chromate of lead or oxyd of copper, as had been found by both Mulder and Boussingault, no conclusion remained, but that the analyses they had recorded, and those we had made, were of different bodies. After the analyses of several compounds of this body with hydrochloric, sulphuric and nitric acids, oxyd of copper, nitrate of silver, and bisulphate of potash, the conviction was established that its constitution was $C_4H_4NO_3$,

to which in crystallized gelatine sugar, an atom of water is united.*

Upon comparing the per-centages derived from this formula with the results of analysis in Boussingault's last investigation, the differences will be seen to be scarcely greater than frequently occur in a series of the best determinations.

The body analyzed by Boussingault, was dried at 120° C., [248° F.] That analyzed by us lost nothing in weight at 150° C.,

* For the anhydrous body, we have adopted the already proposed name GLYCOCOLL. The inappropriateness of the name *sugar*, has been noticed by Dessaigne. The attribute of sweetness it shares with AqO,S_2O_2, oxide of glyceryle and nitrous ether, and beside, it is incapable of fermentation.

We submit the symbol Gl., as least likely to lead to confusion. G. might confound with Glycium, (Glucinum, Beryllium,) and Gly. is already appropriated to *Glycerile*.

[304° F.] When exposed upon a watch crystal to the heat of a lamp, with a metallic screen between, and at such distance that the escape of vapor is barely discernible, a part of the mass in contact with the glass becomes browned, while another portion melts and shoots into crystals. These continue to form even after other portions have become charred. Rubbed together with finely pulverized hydrate of baryta, it becomes almost instantly fluid, the whole dissolving readily in water, from which, in process of time, crystals containing baryta and glycocoll deposit themselves. Here, in the act of combination, the water from one or both the ingredients was given up.

The above circumstances, and others yet to be noted, induced the opinion that at a certain temperature, a lower one longer continued, an atom of water from one half of the hydrated glycocoll might be given up, and the remaining half take its place. This would give almost precisely the analytical results of both Mulder and Boussingault, and yield from the formula determined on by us, precisely the composition given by Mulder.

$$2(C_4H_4NO_3, HO) - HO = C_8H_9N_2O_7.$$

Below, follow the estimated per cent. constitution, according to the above formula, and the average of a series of analyses by Boussingault and Mulder.

	Estimate.	Bous.	Mulder.
8 equiv. Carbon, - - - -	34·04	33·79	34·17
9 " Hydrogen, - - -	6·38	6·44	6·49
2 " Nitrogen, - - -	19·85	19·90	19·84
7 " Oxygen, - - - -	39·73	39·70	39·50
	100·00	100·00	100·00

The effort to expel this half atom of water was unsuccessful. A temperature of 150° C. [302° F.] produced scarcely a perceptive diminution in weight. At 170° C. [338° F.] it began to brown with the escape of gaseous products of decomposition. At 190° C. [374° F.] though portions had become quite charred, others had merely melted and crystallized anew.

The support which the analyses of Boussingault give to the formula $C_3H_4NO_7, HO$,
will justify the following juxtaposition of the estimated per cents. and the actual results.

Glycocoll and Oxyd of Silver; dried at 110° C. [230° F.]

	Boussingault. $C_{16}H_{15}N_4O_{11}+4AgO.$			Horsford. $C_4H_4NO_3+AgO.$		
	Equiv.	Estimate.	Result.	Equiv.		Estimate.
Carbon, . . .	16 = 96	13·35	13·62	4 = 24		13·18
Hydrogen, . .	15 = 15	2·08	2·21	4 = 4		2·19
Nitrogen, . .	4 = 56	7·78	8·07	1 = 14		7·69
Oxygen, . .	11 = 88	12·26	12·35	3 = 24		13·21
Ox. silver, . .	4 = 464	64·53	63·75	1 = 116		63·73
	719	100·00	100·00		182	100·00

Glycocoll and Oxyd of Copper; dried at 120° C. [248° F.]

	Boussingault. $C_{16}H_{15}N_4O_{11}+CuO$.			Horsford. $C_4H_4NO_3+CuO$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon,	16 = 96	23·19	23·57	4 = 24	22·68
Hydrogen,	15 = 15	3·62	3·75	4 = 4	3·77
Nitrogen,	4 = 56	13·53	. .	1 = 14	13·24
Oxygen,	11 = 88	21·29	. .	3 = 24	22·70
Ox. copper,	4 = 158·8	38·37	37·60	1 = 39·7	37·61
	413·8	101·00		105·7	100·00

Glycocoll and Oxyd of Lead; dried at 120°. [248° F.]

	Boussingault. $C_{16}H_{15}N_4O_{11}+4PbO$.			Horsford. $C_4H_4NO_3+PbO$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon,	16 = 96	13·67	13·58	4 = 24	13·48
Hydrogen,	15 = 15	2·13	2·12	4 = 4	2·24
Nitrogen,	4 = 56	7·97	7·78	1 = 14	7·86
Oxygen,	11 = 88	12·57	11·62	3 = 24	13·50
Ox. lead,	4 = 446·8	63·66	64·90	1 = 111·7	62·92
	701·8	100·00	100·00	177·7	100·00

Glycocoll and Nitric Acid, dried in vacuo by ordinary temperature.

	Boussingault. $C_{16}H_{15}N_4O_{11}+4NO_5+9HO$.			Horsford. $C_4H_4NO_3, HO+NO_5, HO$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon,	16 = 96	17·39	17·32	4 = 24	17·39
Hydrogen,	24 = 24	4·34	4·53	6 = 6	4·34
Nitrogen,	8 = 112	20·29	20·23	2 = 28	20·29
Oxygen,	40 = 320	57·98	57·92	10 = 80	57·98
	552	100·00	100·00	138	100·00

At 100° C. [212° F.] this salt lost 9·18 per cent., and at 110° C. [230° F.] 4·5 per cent. more, with which it began to brown. This loss, 13·68 per cent., corresponds nearly with 13·77 per cent., the water in the salt. Its formula would then be

$$C_4H_4NO_3, NO_5.$$

Glycocoll and Nitrate of Silver.

	Boussingault. $C_{16}H_{15}N_4O_{11}+2HO+4(AgO, NO_5)$.			Horsford. $C_4H_4NO_3+AgO, NO_5$.	
	Equiv.	Estimate.	Result	Equiv.	Estimate.
Carbon,	16 = 96	10·07	10·09	4 = 24	10·16
Hydrogen,	17 = 17	1·78	1·84	4 = 4	1·69
Nitrogen,	8 = 112	11·75	11·50	2 = 28	11·87
Oxygen,	33 = 264	27·72	27·87	8 = 64	26·75
Ox. silver,	4 = 464	48·68	48·70	1 = 116	49·53
	953	100·00	100·00	236	100·00

Glycocoll and Nitrate of Potash.

	Boussingault. $C_{16}H_{15}N_4O_{11}+2HO+4(KO, NO_5)$.			Horsford. $C_4H_4NO_3KO, NO_5$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon,	16 = 96	14·14	14·26	4 = 24	14·35
Hydrogen,	17 = 17	2·55	2·42	4 = 4	2·39
Nitrogen,	8 = 112	16·50	. .	2 = 28	16·73
Oxygen,	33 = 264	38·86	. .	8 = 64	38·21
Potash,	4 = 189·6	27·95	27·49	1 = 49·4	28·27
	678·6	100·00		167·4	100·00

Glycocoll and Nitrate of Copper.

Boussingault. $C_{16}H_{15}N_4O_{11}+4NO_5+8CuO+9HO$.				Horsford. $C_4H_4NO_3, HO \left\{ \begin{matrix} CuO, HO \\ CuO, NO_5 \end{matrix} \right.$	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, .	16 = 96	11·02	11·04	4 = 24	11·02
Hydrogen,	24 = 24	2·75	2·89	6 = 6	2·75
Nitrogen, .	8 = 112	12·86	12·08	2 = 28	12·86
Oxygen, .	40 = 320	36·79	37·45	10 = 80	36·79
Ox. copper,	8 = 317·6	36·58	36·54	2 = 79·4	36·58
	869·6	100·00	100·00	217·4	100·00

If we review the estimates from the two systems of formulæ, and the results of analysis recorded above, it will be seen—

1st. That the analyses of the compounds with nitrate of silver, more nearly correspond with the estimates from Boussingault's formula.

2d. That the analyses of the compounds with nitric acid, nitrate of potash and nitrate of copper, are suited equally well to either formula. And

3d. That the analyses of the remaining compounds, viz: with the oxyds of silver, copper and lead, correspond more nearly with the simpler formula.

As additional reasons for adopting the simpler formula, the following, drawn from our investigation, may be recorded.

4th. The analyses give this constitution: as the average of four combustions for carbon and hydrogen, and two for nitrogen, will show, placed side by side with the estimates from the formula

$$C_4H_4NO_3, HO.$$

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	32·00	31·98
Hydrogen, - - - -	5 " = 5	6·67	6·87
Nitrogen, - - - -	1 " = 14	18·67	18·79
Oxygen, - - - -	4 " = 32	42·66	42·36
	75	100·00	100·00

5th. It forms a compound in which sulphuric acid replaces the atom of water: $C_4H_4NO_3, SO_3$

corresponding with Boussingault's nitrate, dried at 110° C. [230° F.]: $C_4H_4NO_3, NO_5$.

6th. It forms a compound with oxyd of copper, of this formula:

$$C_4H_4NO_3, CuO, HO,$$

which, at 100° C., [212° F.] loses an atom of water.

7th. It forms a compound in which the atom of water is replaced by an atom of nitrate of silver:

$$C_4H_4NO_3; AgO, NO_5.$$

8th. It forms, when long digested with sulphuric acid, a salt of this constitution:

$$\left. \begin{matrix} C_4H_4NO_3, SO_3HO \\ H_4NO, SO_3HO. \end{matrix} \right\}$$

The ammonia is taken from the hydrated glycocoll, which may be considered as fumarate of ammonia:

$$C_4 H_4 NO_3, HO = H_4 NO, C_4 HO_3.$$

9th. It decomposes when subjected to the action of the galvanic battery; an acid (fumaric?) and oxygen appearing at one pole, and an alkali (ammonia) and hydrogen appearing at the other.

10th. It may be derived from hippuric acid by treatment with a mineral acid, in which case a neutral salt of glycocoll is formed and benzoic acid set free: or by treatment with potash, in which case benzoate of potash is formed and glycocoll is set free.

Hippuric acid, - -	$C_{18} H_9 NO_6$
Benzoic acid, - - -	$C_{14} H_5 O_3$
Glycocoll, - - -	$C_4 H_4 NO_3$

We may add also that the formulæ of Boussingault and Mulder have not the advantage of so great simplicity.

Preparation of Glycocoll.

The recent brilliant discovery of Dessaigne,* that by boiling hippuric acid with sulphuric, hydrochloric or any of the stronger acids, this body separates into benzoic acid and a salt of glycocoll, rendered the preparation of the latter, in purity, a task of no difficulty. It was, of course, necessary first of all to obtain a quantity of *hippuric acid.*

This acid was prepared according to the method proposed by Dr. Bensch,† by evaporating in a water bath, the morning urine of stall-fed horses, to from one-eighth to one-tenth of its volume; adding hydrochloric acid till all effervescence ceased; setting aside, in a cool place, for the perfect separation of the hippuric acid; filtering through linen, and pressing; dissolving in freshly prepared solution of hydrate of lime, with addition of boiling water; filtering, as before, and pressing; heating the filtrate to boiling, acidifying with solution of alum, cooling to 40° C. [104° F.], adding solution of bicarbonate of soda till no farther precipitation takes place; filtering and pressing; and precipitation of the filtrate with hydrochloric acid. After washing, filtering and pressing the precipitate of hippuric acid, it was again dissolved in boiling water, and blood coal added in the proportion of half an ounce to a pound of moist acid, again filtered at boiling heat through paper, and set aside to crystallize. By this method prismatic crystals are obtained of the most perfect whiteness, an inch in length, and from one to two lines in diameter.

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* Compt. Rend., xxi, p. 1224–1227. Liebig's Annalen, Bd., lviii, S. 322.
† Liebig's Annalen, Bd., lviii, S. 267.

From three to four ounces of hippuric acid were digested in a flask of one litre* capacity, over a spirit lamp, in four times their weight of concentrated hydrochloric acid, until entirely dissolved. A larger quantity is less manageable, and the subsequent treatment less expeditious. It is well to continue a gentle heat, with the addition of water half an hour after the solution is completed. In this time a part of the benzoic acid gathers into oily drops and sinks to the bottom, becoming, as the whole cools, a solid crystalline mass, not easily removed from the flask. The presence of water retains the hydrochlorate of glycocoll in solution. After the whole mass has become cool, the benzoic acid having for the most part crystallized out, the contents of the flask are poured upon the filter and washed till the filtrate no longer tastes sour. The filtrate is then evaporated in an open porcelain basin over a water bath, nearly to dryness,—by which process the excess of hydrochloric acid and benzoic acid are, for the most part, removed. Redissolving and again evaporating two or three times repeated, at length give the hydrochlorate of glycocoll quite pure. Ammonia is then added to the syrup till it yields an alkaline reaction. Absolute alcohol being then added, the remaining traces of benzoic acid and the salammoniac are dissolved, while the glycocoll is thrown down in the form of a white precipitate, consisting of myriads of minute prismatic crystals. As the body is slightly soluble in alcohol, and more so in alcohol containing salammoniac, it is well to let the fluid stand a few hours. The precipitate is then brought upon a filter and washed with absolute alcohol, till the filtrate no longer gives a precipitate with nitrate of silver.

Properties of Glycocoll.

Thus obtained, hydrate of glycocoll tastes sweet, though less so than cane sugar,—has neither acid nor alkaline reaction; dissolves in from 4·24 to 4·35 parts of water; is more soluble in hot than in cold spirits of wine; is quite insoluble in ether, and scarcely less in absolute alcohol.

When heated with a concentrated solution of caustic potash, in excess, it assumes, with the evolution of ammonia, a fine brilliant red color. If the heat be continued, the color gradually disappears.

Heated with hydrate of baryta or oxyd of lead, the same brilliant color is produced.

With sulphate of copper, a trace of glycocoll prevents the precipitation by potash, and the solution assumes a characteristic blue color. Boiled with oxyd of copper or its hydrate, it yields the same blue solution, which, if concentrated, crystallizes in fine needles.

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* = 0·2201 English gallon.

With nitrate of suboxyd of mercury, it gives a precipitate of metallic mercury.

From a concentrated solution in diluted spirits of wine or in water, in process of time large prismatic crystals are formed, which apparently belong to the monoclinate system, of the combination $\infty P.0P.+P.\infty P\infty$. Prof. Kopp, to whom I am indebted for an examination of these crystals and of several others of salts of glycocoll, obtained from crystals prepared by Prof. v. Liebig, an admeasurement of the sharper angles of ∞P, (through which the orthodiagonal passes,) giving $66\frac{1}{4}°$.

The combustions for carbon and hydrogen were made with chromate of lead; those for nitrogen, according to the method of Varrentrapp and Will,—

I. 0·6770 grm. gave 0·7940 carbonic acid and 0·4170 water.
II. 0·5576 " " 0·6607 " " " 0·3474 "
III. 0·4670 " " 0·5455 " " " 0·2882 "
IV. 0·4003 " " 0·4686 " " " 0·2478 "
V. 0·1338 " " 0·4100 platin-salammoniac.
VI. 0·1937 " " 0·5646 " "

These determinations correspond in per cent. with

	I.	II.	III.	IV.	V.	VI.
Carbon,	31·89	32·31	31·81	31·92	. .	. .
Hydrogen,	6·84	6·92	6·85	6·87	. .	. .
Nitrogen,	. .	. .	. .	. .	19·24	18·36

From these may be derived the formula,

$$C_4 H_4 NO_2, HO,$$

as will be seen by comparing the estimated and average actual per cents. of the several elements.

		Theory.	Experiment.
Carbon,	4 equiv. = 24	32·00	31·98
Hydrogen,	5 " = 5	6·66	6·87
Nitrogen,	1 " = 14	18·66	18·79
Oxygen,	4 " = 32	42·68	42·36
	75	100·00	100·00

The atomic weight of glycocoll is, with the above constitution, 66.

Glycocoll and Hydrochloric Acid.

Neutral Hydrochlorate of Glycocoll.

Gl HCl HO.

This is the product of boiling hippuric acid with concentrated hydrochloric acid, as already described. If the filtrate, page 376, be carefully evaporated to syrup consistence, and suffered quietly to cool, the whole mass becomes filled with groups of long, flat prisms, perfectly transparent, and of the greatest brilliancy. The mother liquor poured off, and the crystals washed with spirits of wine, gives the salt in the utmost purity. A second and third

portion of crystals may be obtained by concentrating the mother liquor and similar treatment.

This salt slowly absorbs moisture from the air and deliquesces: over sulphuric acid, the crystals retain their form and constitution any length of time. It tastes sour, and slightly but positively stiptic; reacts acid: dissolves readily in water; in hot spirits of wine, and slightly in absolute alcohol.

The substance dried over sulphuric acid, on combustion with chromate of lead,

I. 0·2368 grm. gave 0·1833 carbonic acid and 0·1272 water.
II. 0·3218 " " 0·2555 " " " 0·1711 "
III. 0·2853 " " 0·5698 platin-salammoniac.
IV. 1·5920 " " 2·0562 chlorid of silver.
V. 1·0008 " " 1·2961 " "
VI. 1·5300 " " 1·9300 " "

Expressed in per cents., the above determination correspond with

	I.	II.	III.	IV.	V.	VI.
Carbon,	21·11	21·28	. .	. .	. .	. .
Hydrogen,	5·96	5·95	. .	. .	. .	. .
Nitrogen,	. .	. .	12·57	. .	. .	. .
Chlorine,	. .	. .	. .	31·91	31·99	31·99

With these numbers, the following formula is in accordance:

$$C_4 H_4 NO_2, HCl, HO,$$

as the annexed comparison will show.

		Theory.	Experiment.
Carbon, - - -	4 equiv. = 24	21·42	21·20
Hydrogen, - - -	6 " = 6	5·35	5·95
Nitrogen, - - -	1 " = 14	12·56	12·57
Oxygen, - - -	4 " = 32	28·53	28·40
Chlorine, - - -	1 " = 35·4	32·14	31·94
	111·4	100·00	100 00

Basic Hydrochlorate of Glycocoll.

(a.) 2Gl, HCl, HO.

This salt is formed by adding hydrochloric acid to a cold concentrated solution of glycocoll in water, and then pouring in alcohol till the solution becomes slightly turbid. Crystals of the utmost transparency and regularity commence forming immediately. To continue the crystallization, alcohol is added drop by drop, at intervals. It is perhaps better to let the solution in water slowly evaporate over sulphuric acid. In this way larger crystals, of surpassing beauty, were obtained. They are rhombic prisms of 87° and 93°. They do not deliquesce like those of the neutral salt, upon exposure to the air. The salt has a pleasant sour, and at the same time sweet taste, reminding one of fine fresh pippins.

The solution reddens litmus with chromate of lead.

I. 0·3505 grm. gave 0·3550 carbonic acid and 0·1743 water.
II. 0·2758 " " 0·6729 platin-salammoniac.
III. 1·5050 " " 1·1940 chlorid of silver.

These determinations expressed in per cents.:

	I.	II.	III.
Carbon,	27·59	. .	. .
Hydrogen,	5·52	. .	. .
Nitrogen,	. .	15·37	. .
Chlorine,	. .	. .	19·58

Correspond with the formula

$$C_4 H_4 NO_3, HCl + C_4 H_4 NO_3, HO,$$

which, calculated, gives:

			Theory	Experiment
Carbon,	8 equiv.	= 48	27·05	27·59
Hydrogen,	10 "	= 10	5·63	5·52
Nitrogen,	2 "	= 28	15·78	15·37
Oxygen,	7 "	= 56	31·59	31·94
Chlorine,	1 "	= 35·4	19·95	19·58
		177·4	100·00	100·00

Basic Hydrochlorate of Glycocoll.

(b.) $2(Gl, HO) + HCl$.

This salt was obtained by dissolving glycocoll in hydrochloric acid and leaving the solution to a quiet crystallization. The exact proportions of acid and base necessary to procuring it have not been determined. Indeed, it will appear obvious, after the accounts of the hydrochloric and sulphuric acid compounds, that the task of accurately fixing the temperature, concentration and quantity of the several ingredients necessary to the formation of a given compound of acid, glycocoll and water, will be exceedingly difficult.

Combustion with chromate of lead gave the following results:

I. 1·0290 grm. gave 0·9840 carbonic acid and 0·5580 water.
II. 1·0890 " " 0·8180 chlorid of silver.
III. 0.9760 " " 0·7305 " "
IV. 0·9710 " " 0·7290 " "

In per cents. expressed,	I.	II.	III.	IV.
Carbon,	26·08	. .	. .	. .
Hydrogen,	6·02	. .	. .	. .
Chlorine,	. .	18·53	18·46	18·41

These numbers conduct to the formula,

$$2(C_4 H_4 NO_3, HO) + HCl,$$

the estimated per cents. of which with the results of analysis are here placed side by side.

			Theory.	Experiment.
Carbon,	8 equiv.	= 48	26·46	26·08
Hydrogen,	11 "	= 11	6·06	6·02
Nitrogen,	2 "	= 28	15·43	. .
Oxygen,	8 "	= 64	33·12	. .
Chlorine,	1 "	= 35·4	18·91	18·47
		186·4	100·00	100·00

The rational constitution of this salt may be considered as one atom of hydrated glycocoll, united to one atom of hydrochlorate of hydrated glycocoll, thus, Gl, HO+Gl, HCl, HO.

Basic Hydrochlorate of Glycocoll.

(c.) 3Gl, 2HCl, 2HO.

This salt was prepared in the same manner as the last; a simple solution of glycocoll in hydrochloric acid, set aside to crystallize. The acid was, however, in excess.

It was also prepared by passing dry hydrochloric acid gas over melted hydrate of glycocoll. For this purpose, a gramme and a half of substance was distributed along the bottom of a Liebig's drying apparatus, and carefully heated with a spirit lamp; at the same time conducting over it hydrochloric acid gas. At a temperature of between 150° C. and 170° C. [between 302° F. and 338° F.] as determined in an oil bath, the glycocoll melts in the acid atmosphere. It was found better, however, to employ the simple lamp. With the latter the apparatus could be readily inclined or half inverted, to spread the molten substance over the interior of the tube, and thus facilitate absorption.

The absorption is attended with the escape of aqueous vapor. The process was continued until no further increase in weight was observed. At each interval the hydrochloric acid was thoroughly removed by long continued passing of dry air through the tube before weighing. At the end of the absorption, the glycocoll usually became slightly green, owing doubtless to a trace of decomposition and separation of carbon.

From an analysis of crystals obtained by the first method,

I. 1·2560 grm. of substance, gave 1·2520 grm. chlorid of silver.

By the other method,

II. 1·9727 grm. of hydrated glycocoll, increased in weight to 2·4580 grm. Precipitated with silver, this gave 2·3855 grm. chlorid of silver. The increase in weight was 24·60 per cent. The per centages of chlorine, I. 24·59; II. 24·23.

These numbers correspond to the formula,

$$3(C_4\,H_5\,NO_4)+HCl+2HO,$$

which requires 24·51 per cent. of chlorine.

Basic Hydrochlorate of Glycocoll.

(d.) 3Gl, 2HCl, HO.

This salt is prepared precisely as the last mentioned, both by crystallization from the acid solution and by leading dry hydrochloric acid gas over fused hydrate of glycocoll.

The notice of this salt would scarcely have been ventured upon, had not a precisely corresponding compound with sulphuric acid been analyzed. It will contribute to show how multifarious may be the relations of a body, that combines as a salt, and yet possesses both acid and basic properties.

From crystals of the salt prepared as above mentioned,

I. 1·2864 grm. gave 1·3203 grm. chlorid of silver.

II. By leading dry hydrochloric acid gas over glycocoll in the manner already described, a compound was formed, of which,

1·1370 grm. gave 1·1845 grm. chlorid silver.

In per cent. expressed, these determinations give,

$$3(C_4\ H_4\ NO_3)+2HCl+HO,$$

which requires 25·30 per cent. of chlorine. As the probable rational constitution of the above salt the following is submitted,

$$(Gl\ HCl+Gl,\ HO)+Gl\ HCl.$$

Anhydrous Hydrochlorate of Glycocoll.

Having found a basic hydrochlorate, which might be regarded as a double salt of one atom of hydrate of glycocoll, with one atom of anhydrous hydrochlorate of glycocoll:

$$C_4\ H_4\ NO_3,\ HO+C_4\ H_4\ NO_3,\ HCl,$$

and especially having found as will be seen below, an anhydrous *sulphate* of glycocoll, it was natural to suppose that the anhydrous hydrochlorate might be obtained by itself, viz. $C_4\ H_4\ NO_3,\ HCl$.

To this end absolute alcohol was saturated with hydrochloric acid gas, and this added to a solution of glycocoll in hot spirits of wine. Upon evaporating the liquid, delicate prismatic crystals appeared which deliquesced with the greatest rapidity. They even dissolved in absolute alcohol. This latter circumstance led to the supposition that the crystals might have been a double salt of hydrate of glycocoll with hydrochlorate of oxide of ethyle. This supposition was further strengthened from an analysis of a sulphate of corresponding constitution soon to be noticed.

(To be continued.)

ART. XXXIX.—*Origin of the Grand Outline Features of the Earth;* by JAMES D. DANA.

THE traveller who follows along the indented shores of a continent, or, traversing the ocean, touches here and there at an island, is likely to become strongly impressed with the common idea that the land has every where the utmost irregularity of form, and that islands are "scattered dots" over the wide seas. Such must be the conclusion of any one who should judge from his own casual observations. Were there a system in the world's physiognomy, it could not become apparent till explorations had traced accurately the varying outlines and elevations of continents, and the positions of islands. A good map or globe is a register of the thousand observations of voyagers and surveyors upon these points. It is a miniature of the world within the grasp of

our view, and may be properly appealed to with reference to the earth's features. The evidence has not been overlooked by the philosophers of the day, and is more or less fully discussed by Humboldt, Malte Brun, L. A. Necker, Elie de Beaumont, Boué, and other geographers and geologists. Yet it has failed of fixing general attention. It is proposed to pass briefly in review the principal facts, and consider the causes to which the existing features of the earth are attributable.

The remarks which follow will be hardly intelligible to the reader without a globe before him, or a Mercator's chart of the world: and the latter, though the best kind of map for the purpose, is somewhat erroneous in consequence of the parallelism of the meridians.

Trends of Coasts and other Features of Continents.—1. On the continent of America, the reader will observe the nearly straight coast line from the Gulf of Mexico along by Newfoundland and Greenland, a distance of 5000 miles; the near parallelism of this line with the southeast coast of South America, 4000 miles in length; also with the line of Lakes Ontario and Erie, and the river St. Lawrence; also with the coast on the northwest of Hudson's Bay, and that by Prince Regent's inlet. These parallelisms are too striking not to be at once obvious. They are instances of a *northeast* and *southwest* trend; and the distance between these great parallel lines are respectively about 3000 miles, 250 miles, 1400, and 380 miles.

Again: look at the west coast of the same continent, from Darien to Russian America, and laying down a rule, mark the near parallelism of the course with the line of great lakes, from Erie through Michigan, Superior, Winnipeg, Slave and Bear, to the coast by the mouth of the Mackenzie; also with the southwest side of Hudson Bay; with the coast on the west of Davis Strait and Baffin Bay, and that also on the east. Here the uniformity is even more remarkable. These are instances of a *northwest* and *southeast trend*. To one of the two lines correspond the greater part of all the grand features of the continent. The apparent exceptions will be hereafter considered. The distances separating these *northwest* lines average respectively 1000 miles, 350, 700, and 400 miles.

2. Compare the sides of the Atlantic Ocean. The southeast coast of South America, from Magellan to St. Roque, is almost an exact continuation of the western line of the opposite continent, by western Africa, Spain, and Norway or the Baltic; and the break in the line made by the Atlantic, is partly filled by the islands Fernando Noronha, St. Paul and the Cape Verds. It will be shown hereafter that the northeast coast of South America belongs to the northwest system of trends, and extends by Guatemala and California northward; and if we cross the ocean,

we find the Cape Palmas coast of Africa, or rather the Kong mountains adjoining, and the Pyrenees between Spain and France, having the same trend as the northeast of South America.

3. In the eastern continent, the western coast of Europe and eastern of Africa have a striking parallelism, in which the north coast of Asia, from the Obo Gulf to the northeast cape, partakes; and so also the east coast of Asia, the east coast of Hindostan, and also the island of Madagascar. These are *northeast* trends. Again, we observe that the Red Sea, Adriatic and British isles, the Persian Gulf, Western Hindostan, and the coast from Calcutta by Malacca, are nearly parallel lines, having the *northwest* trend. Whatever may be said of the exceptions and irregularities, there are evidently too many coincidences to be set aside as mere accident; and the two courses have accordingly been considered by Humboldt, the great geographical lines of the globe.

We might pursue the same course with the mountains. But the general parallelism of the chains with the coast lines, is so obvious that we barely allude to them in this brief outline of the subject under discussion. The fact is plainly true with respect to the great chains of America: and some particulars, soon to be stated, will bring into one system what appears irregular in Europe and Asia. We observe only that Tchihatchef, a Russian traveller, has pointed out the conformity of the main range of the Altai to the course of the east coast of Africa and the island of Madagascar, while there is also a northeast range in the same chain, parallel with the Persian Gulf and Red Sea: the highest point of the Altai mountains occurs at the intersection of the two ranges.*

Trends of Groups of Islands.—We proceed to a few remarks on the islands of the ocean; and they are the more satisfactory, as islands are the culminant peaks of submerged mountain chains, and therefore mark correctly the proper outline features of the earth's surface. The fact that the islands range in lines was long since pointed out; and Malte Brun remarks on the regularity of these lines in the Pacific Ocean. Compare the line in which lie New Ireland, the Salomon group and the New Hebrides, with the Sandwich or Hawaiian range, extending to the northwest through a number of small islets 2000 miles, from longitude 155° W., beyond 180°. Though 3500 miles apart, the lines are nearly parallel; and parallel also with New Caledonia, and with northeast New Holland, on one side, and nearly also with the coast of California and Guatimala on the other; and moreover, these lines are

* Comptes Rendus, May 12, 1845. Tchihatchef observes that the occidental chain runs N. W. and S. E., and the other or oriental, N. E. and S. W. He mentions that a similar system exists in the Alps; but as the identity of direction is not exact, he considers the two systems different.

parallel with the several intermediate chains of islands, as is apparent on the largest charts: the details which are highly interesting will be given by the writer in his Geological Report on the Pacific. Here, then, is an approximate parallelism in ranges over more than a quarter of the circumference of the globe; and nearly all correspond to the *northwest* trend. New Zealand and the Tonga group, and the Ladrones, are examples of the transverse or *northeasterly* trend. The latter trend, (approaching N. N. E.,) characterizes a part of New Holland, the Australian Alps of the southeast, and as observed by Fitton,* the west coast of the Gulf of Carpentaria and the islands off its north cape; besides, also, the northwest coast: the inlets of the coast correspond almost uniformly to one of the two courses pointed out. The Galapagos illustrate distinctly both trends, and they are so mentioned without alluding to any general law, by Darwin.† Beyond the American continent, in the Atlantic, we find the Azores closely parallel with the Hawaiian line; and the same is illustrated in the Canaries, according to the position of the islands given by von Buch,‡ and also in the Cape Verds. These lines are also parallel with northeast South America, and the Pyrenees. Thus, not only over one ocean, but over both, the same system prevails, and alike also over the intermediate continents, the one corroborating the other. The system in truth belongs to the world. To this conclusion Humboldt, Necker, Boué, and other geologists appear to have arrived.

But if we survey the facts more minutely, may we not find that an element in this branch of physical geography has not been properly apprehended? Do not the exceptions throw in a vexatious doubt, if they cannot be blended with the theory? We propose, then, to pursue the subject still farther; and we believe that instead of proving that there are as many distinct systems in orography as there are mountain courses,§ it will

* Sketch of the Geology of Australia, Phil. Mag., 1826, lxviii, 18, 132. The regular lines of islands were observed by Flinders, as remarked by Fitton, (ibid., p. 132.) See Flinders's Voyage, ii, 246.

† Volcanic Islands, p. 115. "Three great craters on Albemarle island, form a well marked line, extending N. W. by N. and S. E. by S.; Narborough island and the great crater on the rectangular projection of Albemarle island, form a second parallel line. To the east, Hood's island and the islands and rocks between it and James' island, form another nearly parallel line; which, when prolonged, includes Culpepper and Wenman islands, lying seventy miles to the north. The other islands, lying further eastward, form a less regular fourth line. Several of these islands and the vents on Albemarle island, are so placed that they likewise fall on a set of rudely parallel lines, intersecting the former lines at right angles; so that the principal craters appear to lie on the points where two sets of fissures cross each other."

‡ Les Iles Canaries, 369. The craters of Gran Canary, Teneriffe and Palma, are in a northwest line, while a transverse trend is distinct in the several islands.

§ Essentially the theory of Elie de Beaumont, in which view he is supported by many distinguished names in geology.

appear more in accordance with facts, to refer even wide deviations of directions to one and the same system.

General character of the lines of Mountains, Coasts, and Islands.—A careful study of the courses of island groups, coasts and mountain chains, leads us to the following important results:—

I. *The ranges are made up of shorter consecutive and sometimes parallel lines, instead of being uninterrupted for long distances.*

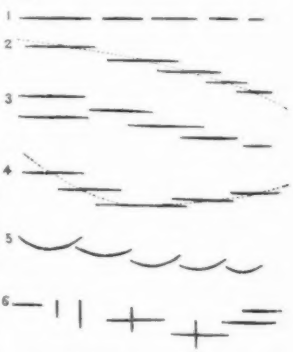
II. *The ranges are more commonly curved, than straight or coincident with the course of a great circle.*

III. *The straight ranges are generally straight in the constituent lines, but may consist of a series of curves.*

IV. *Curved ranges may arise from a general curvature in the whole; but often proceed from the positions of the several consecutive parts.*

V. *The same range, owing to the mode of curving, may vary greatly in its course, in different portions.*

In these points we are stating merely the facts or results of observation, free from speculation. The following figures may serve to illustrate the propositions stated.



In figure 1, the entire range is straight, as well as the parts.

In figures 2, 3, and 4, the parts are straight and overlap, and thus form a range which is sometimes straight as a whole, but is more frequently curved. The direction of the whole range, as shown by the dotted line, differs from the direction of the subordinate lines.

Figures 3 and 7 represent a common condition in which there are parallel lines in some parts of a range.

In figure 5, the parts are curved; and here, too, the resulting range may be straight or curved.

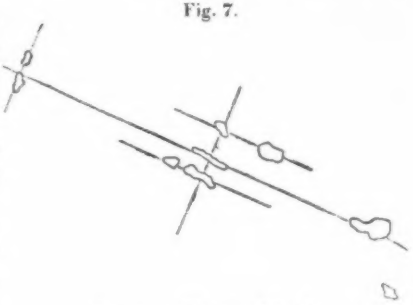
Fig. 6 represents a range made up of longitudinal parts along with some transverse; this is of common occurrence (figure 7.)

The more thorough the examination of the trends of groups of islands and of mountain chains, the more distinctly will this system of things be apparent; and instead of straight lines, or parts of great circles, it will be found that the predominant courses in the earth's features are curves. All these points might be abundantly illustrated by the groups of the Pacific islands; but we omit the details, as the subject will be fully presented in the Report, by the writer, on the Geology of the Ocean. Suffice it to say, that in the Hawaiian range these principles are distinctly

represented; so also in the Samoan group, the Kingsmills, the Ladrones, and others.

The citation from Mr. Darwin, in the note to p. 384, exhibits both parallel and transverse lines in the Galapagos; and in the Canaries there are similar facts. The position of the Azores here given, well illustrates the subject. The main parallel lines are too obvious to require particular remark, and the transverse are also apparent.

Fig. 7.



Azores or Western Islands.

A system of curves, on a grand scale, is seen along the east of Asia, resembling figure 5. The reader, to appreciate the facts, should refer to his map, and the best and largest within reach.

The *first* of these curves extends from Kamschatka south by the Kuriles to Yeso, and is 1500 miles long; a *second*, from Yeso, or the island Sanghalian just north, along Niphon to its southwest extremity, 900 miles long; a *third*, from the southwest extremity of Niphon, through Kiusiu and other islands, to Loochoo and Formosa, about 900 miles long; a *fourth*, from Formosa, by Luzon, Palawan and the western coast of Borneo, 2000 miles long. These curves are singularly alike in form and relative position.

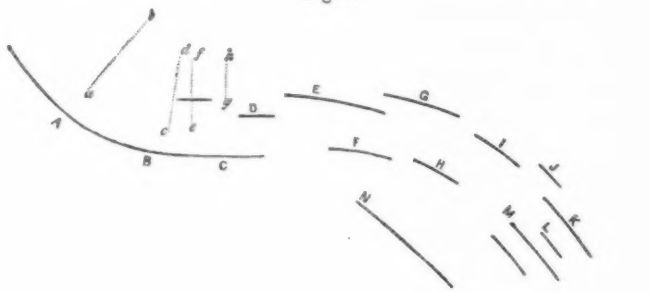
These coincidences are facts: accidental, that is, without a cause, no one will pretend. The Alaschka Archipelago, at the north, seems like a part of the same system; it forms a regular curve, 1600 miles long, between Kamschatka and Russian America.

Another corresponding system is apparent in the west coast of Asia, though less regular, as its outline is varied by differences in the extent of the plains and slopes of the land. But we cannot fail to observe the curving lines from Okhotsk south to Pekin; from Pekin to Tongquin; and perhaps also from Tongquin to Malacca. The mountain ranges of the eastern side of the continent also correspond, as laid down on the best charts. The Stanovoi and the Khingan mountains form three great curves of similar character, convex in the same direction; and the Altai range, farther in the interior, is parallel with the last.

When the particular islands in the curved lines south of Kamschatka, are laid down with minute accuracy, there is reason to believe that each of the curves pointed out, will be found to be not a simple curve line throughout, but a compound one, having some degree of resemblance either to figure 2, 3, 4, 5 or 6.

On a large recent map of the Pacific and East Indies, the range of the New Hebrides (K, fig. 8) and the nearly parallel New Caledonia, (M,) is observed to be continued in the Salomon islands, New Ireland and Louisiade group, (I, G, H,) as before stated; but the range, we remark farther, is becoming to the westward, gradually more east and west in direction, changing from N. 40° W. to N. 65° W. The range does not stop here: it is continued

Fig. 8.



A. Sumatra; B. Java; C. Sumbawa; D. Ceram; E. North New Guinea; F. South New Guinea; G. Admiralty and New Ireland; H. Louisiade; I. Salomon Group; J. Santa Cruz Group; K. New Hebrides; L. Brittania Group; M. New-Caledonia; N. Northeast Australia; O. North New Zealand.

in New Guinea, (E, F,) falling off still more towards an east and west course; and the southern division of it, at least, is continued farther through Flores, Sumbawa, and Java, (C, B,) and from the last island trends northward through Sumatra (A) and the Andaman Islands. This is an example of a long curving range; and we may properly connect with it, northern New Zealand, northeastern New Holland, and the islands between this coast and New Caledonia. Viewing the broad band, we observe the whole conforming to one system; and the separate parts, if analyzed on a good map, confirm each the same principles.

Malte Brun mentions the great range of the central Pacific from the Marshal Islands by the Samoan to the Austral Islands south of Tahiti, which is full 5000 miles long. Leaving the particulars for another place, we observe only that this great range curves north as it goes westward, varying from N. 66° W. to N. 35° W.

It is also true of mountain ranges that they have this compound character, though they have seldom been surveyed with sufficient care to allow of deriving much accurate knowledge of them from maps or descriptions.

In the valuable work on New South Wales, by Strzelecki, this intelligent and laborious traveller mentions and figures the succes-

sive curves, convex westward, which characterize the mountains of Eastern Australia, and without reference to any hypothesis, or to such a system of things elsewhere. Profs. Rogers in their elaborate papers on the Appalachians, mention that these mountains, in their course from Maine to Georgia, are made up of a series of great curves, which they describe separately and with detail. We shall allude, on a following page, to Dr. Percival's interesting observations on the trap ridges of New England, which sustain the same principles in all their detail. Sufficient has been brought forward to illustrate the general fact, that the great chains of mountains, as well as of islands, are interrupted ranges, consisting of overlapping lines, either straight or curved; and that curves constitute an essential feature in the system. We have, therefore, but a small part of the truth in the conclusion before stated, that there are two prevalent trends in the system of the earth.

There is still another point to be observed before we are prepared to draw any conclusions from the facts. Namely:—

VI. *The approximately rectangular intersections of two systems of trends wherever they occur together.*

The curving direction of the Java range has been pointed out in its course from Sumatra east. Looking again at the map, the reader will observe that the coast lines of the large islands north, are approximately north and south in direction; but vary exactly with the Java curve. Celebes and Gilolo are north and south (*ef*, *gh*, fig. 8) like western Mindanao; and correspondingly, the Java line in the meridian of Celebes, is east and west. The east coast of Borneo varies a little to the east of north, and a line drawn along it (*cd*, fig. 8) would meet the Java range at right angles, or where this range inclines about as many degrees to the north of west. The west side of Borneo varies forty degrees to the east of north, (*ab*, fig. 8,) and at the same time the Java range, where the line of this side continued would meet it, has a like variation to the north of west, not differing even a degree, thus making the intersection rectangular. Hence it would seem that the shape of Borneo was connected in origin with the trend of the Java range; and not only this, the whole surface covered by the islands from Luzon to the Java range, has nearly the same shape as Borneo.

The successive curves on the east coast of Asia, are nearly at right angles with one another at their extremities. Thus Niphon stands nearly at right angles with the south extremity of the Kurile range; so Kiusiu, with the same extremity of the Japan range: and also Formosa with that of the Loochoo range.

In New Zealand, the two systems, as shown by the outline of the group, are nearly at right angles. The Tonga range is nearly at right angles with the Samoa or Navigators. Passing by other facts in the central Pacific, the Galapagos present the same rect-

angularity of the two systems. The line of active vents in Mexico and that of the great chain are at right angles, as stated by Humboldt, and the former is parallel with Cuba. The Canaries present the same facts as the Galapagos.

We often find parts of a chain at right angles with the rest, as illustrated in figure 6. In the chain of lakes from Lake Erie to Bear, which has the *northeast* course, several of the lakes themselves are oblong *across* this course. This is the case with the parts of Bear lake, with Slave lake, Athabasca, and the northwest shore of Superior; and the whole line is at right angles with the line of the St. Lawrence, Ontario, and Erie. Indeed such facts are closely connected with those first stated with regard to the relation of the two prevalent trends of the globe, the northeast and northwest, and have long been recognised.

We have not alluded to a highly important branch of the subject:—the direction of cleavage joints in rocks. It has often been observed that there is a general correspondence between them and the direction of the mountain ranges of a region. Necker has presented a great variety of facts on this subject, showing the prevalence of northeast and northwest lines in Europe and elsewhere.* Professor Sedgwick, in 1831, stated the law of parallelism.† De la Beche mentions the same in Devon and some other parts of England, where north-northwest and a transverse direction are the common courses.‡ Phillips observes that in Yorkshire, fifty-five out of eighty-nine of the cleavage joints observed by him, were between northwest and north, and twenty-eight were at right angles with these; only six were anomalous. The same facts have been remarked by other English geologists. Fitton has presented similar facts from Australia.§ Mr. Darwin in his work on South America, gives various facts showing that the principle holds west of the Andes, that the cleavage joints are in general parallel to the mountain range. It is also true of the United States, east of the Appalachians. We observe therefore that the question with regard to the cause of this structure is intimately connected with that of the origin of mountains.

This survey of the geological features of our globe leads to several important conclusions.

A. *That the earth has a strongly marked physiognomy, or a system in its grand outlines.*

B. *That throughout this system, northwest and northeast lines are every where prevalent.*

C. *That these strongly drawn lines are usually curved instead of conforming to the direction of a great circle; and*

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* Bibliothèque Univ., de Genève, xliii, 166. 1830.
† Trans. Geol. Soc., London, ii ser., iii, 68.
‡ Geol. Rep. on Cornwall, Devon, and W. Somerset, 8vo, London, 1839.
§ Sketch of the Geology of Australia, Phil. Mag., lxviii, 135.

whether curved or straight, consist of a series of subordinate parts ; these parts having often a different direction from the line of the range.

D. *That the lines, even when curving, cross or meet any transverse lines very nearly or quite at a right angle, the one dependent on the other or varying with it.* Consequently—

E. *That the same grand chain may vary even sixty degrees or more in its course, and hence the trend of a ridge is no independent evidence of its age.* Thus a northwest course may gradually change to an east and west, as in the great Java range from New Hebrides to Java, and thence become northwest again, as in Sumatra:—a west-northwest range may change to north-northwest, as in the great Pacific chain from the Society Islands to the northernmost of the Marshall group. A north-northeast range may change through northeast, to east and west; and also a north and south range may go through the same changes, as shown along the east coast of Asia and elsewhere.* Just west of New Guinea the east and west line is a little north of east in Timor. Consequently, while northeast and northwest lines are on the whole most common, there are other courses to be considered, and all are so dependent that they evidently must have a common explanation.

Causes of the Earth's Features.

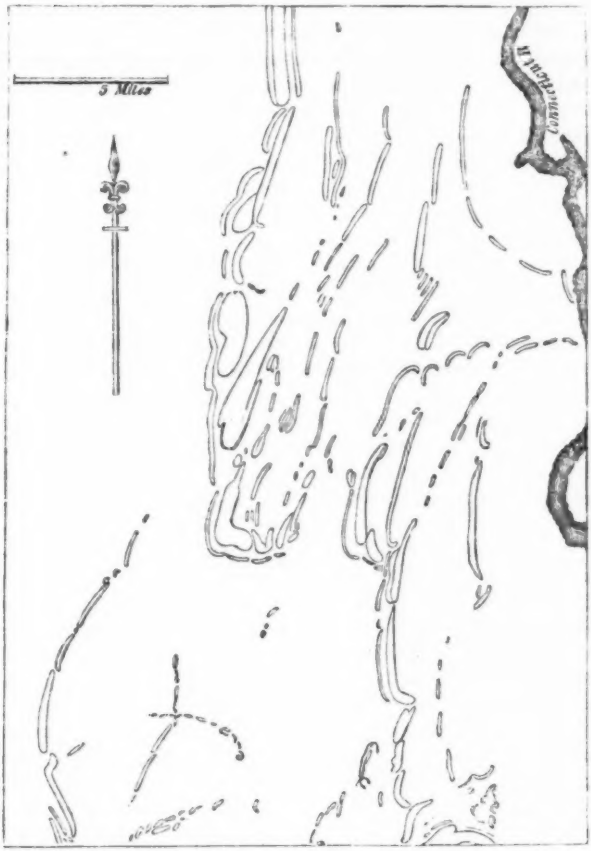
The direction of mountain chains is universally attributed to the courses of former fissures in the earth's surface; and as islands come under the same head, and coast lines are mostly dependent on the ranges of heights adjoining, the question before us is reduced to this:—What can have occasioned such *ranges of fissures*, with their several peculiarities; their composite character, general uniformity of direction, curves, irregularities, and usual rectangular intersections?

Peculiarities of Fissures.—Before proceeding farther, it is important to understand the general character of fissures; and we present a case to the point from the map accompanying the elaborate Report of Dr. J. G. Percival on the Geology of Connecticut;†—a work of vast labor, and of minute and cautious research, by one of the ablest men of America. Dr. Percival has afforded us a key to this subject, of the highest value, by the results of his investigations among the trap dikes of New England. The chart annexed is a small section of the map near its centre, showing the positions of the dikes or trap ridges. They commence twelve miles south of the portion here given, in the vicinity of New Haven bay, and extend northward into Massachusetts, and beyond into New Hampshire.

* The same principle is recognized by the Professors Rogers, in view of the facts observed by them in the Appalachians. Trans. Assoc. Amer. Geol., 1840-42, p. 540.

† Report, &c., by James G. Percival, 495 pp. 8vo., New Haven, 1842.

Fig. 9.



The dikes (courses of fissures) have the following characteristics:—

1. A general uniformity of direction.
2. A situation in several parallel ranges.
3. An interrupted character, and a frequent advancing or receding in the successive parts of a line, or an overlapping of the extremities, as in figures 1, 2, 4, 5, constituting what Dr. Percival has well designated "advancing," "receding" or "continued" series.
4. Curved lines; some simple, others composed of several straight lines, and others of subordinate curves.
5. Various irregularities in the lines, and deviations from parallelisms, although belonging to the same general system.

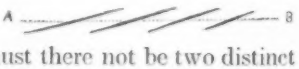
These peculiarities, as laid down and described by Dr. Percival, are confirmed by the writer's observations on dikes elsewhere and by fissures in volcanic regions.

We have in the above, an example on a comparatively small scale, of the general characters of fissures; and we find that it is an almost exact representation of the facts presented by the prominent features of the earth. The coincidences confirm the view that the ranges of mountains and islands correspond to ranges of fissures, and also illustrate their subordinate peculiarities.

The formation of many associated fissures, instead of a single rent, is the natural result from the general character of the material ruptured, and the manner in which the force must act.

Causes of the general uniformity, and composite character of ranges.—The most important point with relation to the ranges, is their general uniformity over the globe. These great systems of parallelisms must have arisen from the ruptures taking place in certain directions rather than in others, and the cause lies either in the forces causing ruptures solely, or in them in connection with the nature or structure of the earth's crust: and if the latter, the structure must be coextensive with the world, as the facts have no narrower limits. The annexed figure illustrates as we have stated a common character of ranges. To produce such a result must there not be two distinct causes, a force to rupture, and a structure to determine the direction of the lines? Were there no structure, the force should have produced a fissure in the general direction of the dotted line A B. But instead of this effect it produced a series of parallel lines oblique with this course. We can conceive of such a systematic result only on the ground that there is a tendency to fracture in a certain direction; and the force is applied obliquely to the lines of easiest fracture. Such ranges, as that of the Hawaiian for example, may exceed a thousand miles in length: and the great central range of the Pacific, 5000 miles long, illustrates the same point, proving the existence of directions of easiest fracture in the very nature of the earth's crust. The fact of such a structure has been suggested by Necker,* De la Beche,† Boué‡ and other geologists.

Fig. 10.



The nature of this structure, or the cause of this tendency to break in two directions, is a difficult subject of inquiry. The material of the crust, to which we naturally look for an explanation, is crystallized rock, for all igneous rocks are crystalline in their nature on cooling; and we observe that such rocks often break most easily, in certain directions dependent on the crystallization of some one of the included minerals or the position

* Bib. Univ. de Genève, xliii, 1833, 180.
† Geol. Report on Cornwall, Devon and W. Somerset. p. 281.
‡ Bull. Soc. Geol. de France, xiv, p. 439, 1843, and ii Ser., i, pp. 353, 355. 1844.

of crystalline grains; though there may be also other independent lines of fracture. There is abundant evidence of a uniformity of cleavage direction in the rocks of the surface over large areas, as already explained. Such a cause would have acted more uniformly at the first cooling of the surface, when from the previous free liquidity, the material was more uniform in character than at any time afterward: and even though the material were different in different parts, it matters little, since feldspar is common in almost every igneous rock, and is a frequent source of cleavage in two directions at right angles with one another, independently of the foliation due to mica and hornblend when either of these minerals are present.

M. Necker, in the article already alluded to, suggests that the trends of mountains, coast lines, and the strike of strata, coincide with *magnetic curves*. The same cause is appealed to by Boase* and De la Beche, on the ground that the electrical currents traversing the globe may influence the polar forces of crystallization. It has since been demonstrated by Mr. R. Hunt that the direction of crystallization is influenced by magnetism,† and R. W. Fox had before shown the action of electrical forces in determining the direction of lamination.‡ The magnetic chart of the world, by Captain Sabine in the sixth Report of the British Association, exhibits some striking coincidences throughout the Pacific; the exact trend of both the Hawaiian and Samoan groups and also the east and west courses in the East Indies and in the West Indies, correspond with lines on his chart. The exceptions are many and look insurmountable; but they are to some extent removed by a knowledge of other sources of influence. It should also be remembered that lines of magnetic intensity, as Brewster has shown, correspond nearly with isothermal lines; and the two agencies, heat and magnetism, must therefore have acted in some degree together, at all periods.§

Hopkins in his able "Researches on Physical Geology,"‖ (1835,) attributes the regularity of joints in rocks to the mechanical action of an elevating force, and he establishes a perfect uni-

* Treatise on Primary Geology, by H. S. Boase, M. D.; 8vo, London, 1834, and L. and E. Phil. Mag., and Jour. of Sci., ix, 4; x, 14.

† Phil. Mag., Jan., 1846, p. 1; Amer. Jour. Sci., ii Ser., ii, 116.

‡ Report of the Polytechnic Society of Cornwall, for 1837, pp. 20, 21 and 68, 69.

§ M. Boué observes:—Sans avoir besoin de supposer que la terre ait été primitivement un cristal, il suffit de lui *accorder un certain ordre dans ses irrégularités de surface en harmonie avec son mode de refroidissement, ses forces intérieures et les forces centrifuge et centripète.* Ceci admis, on en doit déduire nécessairement que les premières mers ont occupé les parties du sphéroide les plus accidentées, certaines grandes chaines offrant encore les indices de ces formes régulières, ou pseudo-régulières; et puisque ces séries de montagnes constituent l'ossature des continents, et déterminent leur figure, on voit de nouveau combien la similitude des continents éclaire *l'etude pour ainsi dire cristallographique du noyau terrestre.* Bull. de la Soc. Geol. de France, i, ii Ser., 355.

‖ Trans. Camb. Phil. Soc., vii, 1.

formity between the facts and the necessary effects of this cause. Mr. Darwin adopting essentially the same view in his remarks on the parallel relation of the planes of cleavage in western South America to the axis of the Andes range, explains the uniformity by supposing the mass to have been subjected to tension unequal in different planes, arising from the elevation of the mountains.* Mr. Sedgwick in his valuable memoir "On the Structure of Large Mineral Masses," (1835,) also appeals to tension as the cause, and supposes that this tension may arise from the contraction attending solidification.† If tension be the proximate cause, the various facts require that both sources of it, the mechanical and that of refrigeration, be equally appealed to.‡ With reference to this subject, it should be considered that if curves of magnetic intensity are approximately isothermal lines, they must have been lines of equal cooling, and consequently *lines of equal tension*. This cause would then coöperate with the electrical, and might aid in producing the general uniformity of trend, which could not proceed from contraction alone. Acting during the period of early cooling, its effects should therefore have been universal: and through subsequent ages, the cooling or crystallization, *beneath* the crust, making still slower progress, (inconceivably slow,) would have continued to be governed by the same cause, liable to those modifications that isodynamic lines have undergone. But a perfect correspondence in the *surface* plutonic rocks, with the structure of the crust, should not be expected, since the lines of tension, determining the structure of the former, must have depended somewhat on the direction of the force producing fissures and mountain elevations.

The bare possibility that the earth's axis of rotation has been at any time changed, suggests that a cause may have coöperated in these results, whose influence cannot be fully estimated. Yet if magnetism has been a cause of structure, the coincidence of trend with existing curves of magnetic intensity tends to prove that such a change of axis has not taken place. It would be a grand result for geology if the science should settle this debated point. The coincidence of the magnetic curves with the trends in the central Pacific and north of New Holland, and also in the West Indies, is so close, that we have reason to suspect that the two facts are some way mutually dependent and have always been so. Still if the earth's axis may have changed, it is possible that the trends may once have had a direction that could have been

* Darwin on South America. 8vo, London, 1846. p. 163.

† Trans. Geol. Soc., London, ii Ser., iii, 480, March, 1835.

‡ Tidal movements in the fluids during incipient cooling might be a source of tension, transverse to the line of motion. And a gradual change in the oblateness of the globe would be another source of tension. But it does not appear that the existing system would correspond with the possible effects of either of these causes.

mainly caused by tension consequent on a diminution of the earth's oblateness.

Whatever the origin, there can be no doubt of the *fact*, that a kind of cleavage structure, or, at least, a capability of fracturing most easily in two directions, was given the crust during its formation, and that such a structure has influenced the direction of the lines of fissures that have since taken place. And while there is evidence of this structure, there is proof that the rupturing force often acted obliquely to the planes of easiest fracture, causing deviations from straight lines in the long ranges. The next question is with reference to this *rupturing force.*

Contraction is a known dynamical cause that must have begun with the beginning of refrigeration; and it is hence essential to consider how far it meets the various facts in view. In the theory of mountain ranges, by Elie de Beaumont, this agency is appealed to; we believe as confidently in its efficiency, though led by the facts to somewhat different results.

The effects of contraction have been illustrated elsewhere in this volume. A prime feature in the operation of cooling, influencing all the results proceeding from it, depends on the tendency of heat to spread itself circularly, or to diminish circularly, around a centre. This cause gives a circular form to pools of lava, and they retain this form as they cool. The great crater areas of the moon, several hundred miles in diameter, illustrate it; and this size is no necessary limit to their extent. In a cooling globe there would therefore be necessarily such vast circular or elliptical areas. Here then we perceive a cause modifying all the results of cooling; and we observe that throughout all ages there must therefore have been some reference to such circular or elliptical areas in contraction; and especially, to aggregations of such areas, which also would be more or less curvilinear in outline, and would act as a whole in the progressive subsidence.

The force of tension in the crust from contraction beneath, is exerted to a great extent horizontally; and in a subsiding area, the direction would be nearly radial, or from the centre outward. This cause then should generally *act obliquely to the lines of structure*, though sometimes coincident with them. If the tension cause ruptures, the rents should follow the lines of cleavage structure in the earth, in case the direction of the force corresponded; otherwise a series of rents should result having a direction of range different from the direction of the line of structure. The peculiarities of fissures, which have been explained, the "receding," or "advancing," or "continued" series of parallel courses, and the curved directions, are therefore necessary effects of the cause appealed to. Curved as well as straight ranges, ought therefore to characterize the grand features of the globe.

The important generalizations of Mr. Hopkins with regard to the *direction of fractures* and the necessary *dependence of two*

transverse lines in an elliptical area under a state of tension, not only remove any difficulty arising from the existence of two transverse systems and their rectangular intersections, but actually require this result.*

Areas of non-contraction or of comparative slow contraction, should modify the direction of the ranges of fissures formed in a surrounding region where more rapid contraction is going on. Also, the interference of two contracting areas would produce irregularities; still wider effects would proceed from more extended combinations, such as have produced the oceanic depressions and the continental areas. Thus the continents which were early free from fires† have generally experienced the tension along their borders; and fissures and mountain ranges, frequently several in parallel series, have been formed, whose main courses are a resultant between the direction of the planes of cleavage structure in the earth and the action of the force of tension arising from the contraction going on over the oceanic areas.‡ Causes of certain irregularities in mountain ranges were mentioned on page 185 of the last number of this Journal, and these discussions afford a more extended view of the action of these causes. The principles explained in the paper just referred to, have here their full application.

Any other cause besides contraction, occasioning elevations or subsidences would produce the same general result as regards direction of lines of fissures; but we know no other cause of probable operation that would be so related to elliptical or circular areas; and thus none but this cause appears to satisfy the conditions presented in the frequent curvilinear forms of ranges.

The positions of some great contracting areas may be distinguished over the oceans, from the curving lines which enclose them. The great Pacific range of lands, from the Marshall Islands to the Society group, 5000 miles in length, has been described as convex to the southwest, while the line of the Hawaiian range, 2000 miles long, is nearly straight. May not this part of the ocean have been one of the large *compound* contracting areas, and a line from Pitcairn's, in lat. 25° S., long. 130° W., to northern Japan the course of its axis? Using the registers of

* The mathematical deductions of Mr. Hopkins were made with special reference to the elevation of the Wealden, though brought out so as to be of general application. He lays down the facts, that in "districts where faults abound, two distinct systems are usually found, in each of which the faults approximate to parallelism with each other;" and that "the common direction of one of these systems is approximately perpendicular to that of the other;" and he establishes the necessary dependence of these transverse systems by calculation.

The mode of producing the tension required by fracture is different in the foregoing explanations, from what is assumed by Mr. Hopkins; but it does not appear to alter the general results; and it is believed to set aside some objections urged by Dr. Boase to the conclusions of Mr. Hopkins. See *L. and E. Phil. Mag., and J. of Sc.*, ix, 4, 171, 268, and x, 14. 1836.

† See this Journal, ii, 132, and iii, 181.

‡ Ibid, iii, 98, 181.

subsidence, so happily distinguished and brought forward by Mr. Darwin, the Coral Islands, we have evidence that an elliptical area with the same line for its axis was subsiding even as late as since the tertiary epoch. The very region therefore which bears evidence of having been the original great elliptical area of contraction for the Pacific, on which the courses of the islands were in part dependent for their direction, was also undergoing contraction till within a late period; and we know not that some parts about the Northern Carolines—the nearest to the centre of the area—may not still be contracting as there is some evidence of it, which the writer will elsewhere present. The *transverse* line including New Zealand, the Kermadec and Tonga Islands, crossing the other systems nearly at right angles, would pass in its course northward the Samoan and Hawaiian Islands, and also some smaller groups intermediate.

The position of a large area undergoing *little contraction compared with the region around*, is before us in New Holland, as is evident from the absence from this semi-continent of volcanoes or their remains. Such an area would occasion a tension acting to some extent circularly around it; and which might determine the courses of ranges in its vicinity. The ranges of islands from New Zealand by the New Hebrides to New Guinea and Java, is just such a concentric range, as the view would seem to require. Borneo is another vast region without volcanic traces over its interior, and may have influenced the upward trend exemplified in Sumatra. However this may be, the cause brought forward—large isolated areas of comparatively slight contraction,—must have had their influence in determining the direction of lines of tension or of forces causing rupture.

M. Boué remarks that the trends in the tropics in general approach a parallelism with the equator, and he attributes the supposed fact to the centrifugal force of rotation. It holds true to a considerable extent. There are however so many exceptions that we may perhaps doubt whether the fact is sufficiently general for so general a cause.

The conclusions which appear to flow from the facts that have been presented, are as follows:—

That the general direction and uniformity of the grand outline features of the globe may be in a great degree the simple effects of the earth's cooling: this operation resulting in (1) solidification, and under the circumstances, whatever they were, an attendant jointed structure or courses of easiest fracture, in two directions at right angles nearly with one another, both varying together according to the rates of cooling in different parts;—and (2) occasioning tension in the crust through the contraction going on beneath, with some relation to circular areas but especially to large compound areas, which tension caused ruptures conforming

or not to the lines of jointed structure according as the force of tension acted in accordance with this structure or obliquely to it. (3) The age of mountains cannot therefore be determined necessarily by their courses; a different direction in a particular region in different ages is not improbable, since the same contracting area might exert its horizontal force in somewhat different directions at different epochs, or other such areas might coöperate, and exert a modifying influence; and at the same time, an identity of direction for different ages was to have been expected.

From the facts before us it may be inferred that the great volcanic band which is drawn by von Buch in the East Indies, in the shape of the letter U, from Sumatra and Java around by the Philippines, gives an incorrect view of the volcanic system in that part of the world. Much the larger part of the Philippines consists of primary and secondary rocks instead of volcanic, and in Luzon, the southern volcanic portion corresponds nearly to the west-northwest trends of the Pacific. The volcanic line of Sumatra and Java, including also the islands farther east, belongs, as we have shown, to the system of the Pacific, to the northwestward courses which characterize nearly all the groups of that ocean; and it is continued east by a volcanic line along North New Guinea to the New Hebrides. Although an erroneous impression may therefore be conveyed by the chart of von Buch, it presents properly the fact intended to be illustrated by its distinguished author, that volcanoes prevail along the track laid down. The band seems like a grand volcanic border to the Asiatic continent, stretching from the vicinity of northern New Holland, (and we may say from New Zealand,) to Kamschatka; and it curves around into the great American range through the Alaschka Archipelago.

It is a fact of no little interest that the Pacific Ocean should thus be nearly encircled with volcanoes, active or extinct, as well as by high mountains, while the sides of the narrow Atlantic and Indian Oceans have comparatively few traces of such fires; and it tends to confirm the opinion thrown out as to the agency by which the deep ruptures and elevated ranges of the globe have been produced.*

This subject properly forms an introduction to the preceding papers on the earth's contraction, in this volume;† and the whole is offered as a simple view of the earth's dynamics, the sufficiency of which is to be tested by future discoveries.

NOTE.—On page 188, it is implied that Lyell and Poisson admitted the former fluidity of our globe; whereas the writer simply intended to acknowledge that these authors first brought forward the argument that a crust could not form upon a globe while it was in a state of free liquidity. See Lyell's Principles, ii. 439, where Cordier is mentioned as having presented the argument subsequently to himself.

* See this volume, pp. 96, 98, 181, 185, 186. † Ibid, pp. 94, 176.

ART. XL.—*Notes on the Algæ of the United States;* by J. W. BAILEY, Professor of Chemistry, &c., at the U. S. Military Academy.

(Continued from Vol. iii, Second Series, p. 80.)

IN the continuation of the list of Algæ hitherto found in the United States, I have thought it best to adopt for the Conferveæ, the names employed by Harvey, in his Manual of British Algæ; for although the recent subdivisions of the old and heterogeneous genus *Conferva*, are doubtless necessary and proper, yet Algologists do not seem agreed as to what names shall be generally adopted. The old and well known names will answer all my present purposes.

LIST OF NORTH AMERICAN ALGÆ, (CONTINUED.)

Conferva alpina? Bory. Murdiner's Creek, near Newburgh, N. Y.; v. sp., in herb. Tor.

Conferva ericetorum, Roth. Salem, N. Ca., Schweinitz!

Conferva floccosa, Ag. Salem, N. Ca., Schweinitz! Rhode Island, S. T. Olney. West Point, N. Y. Common.

Conferva bombycina, Ag. Salem, N. Ca., Schweinitz! Rhode Island, S. T. Olney. Ponds near West Point.

Conferva rivularis, Linn. Common from Maine to Ouisconsin, and south to Virginia.

Conferva aerea, Dillw. Narragansett Pier, S. T. Olney! Newport and Seaconnet.

Conferva (*Elachista*) *fucicola*, Velley. Very common on *Fucus vesiculosus* at Stonington, Newport, &c.

Conferva fracta, Fl. Dan. West Point, N. Y. Providence, R. I.

Conferva glomerata, Linn. Lake Ontario, Pickering! Falls of Niagara, and in Lakes Erie, Huron and Michigan. Also in Fourth Lake, near Madison, Ouisconsin.

Conferva refracta, Ag. Eastport, Maine, Rev. J. L. Russell! Very common on shores of Rhode Island. I have not now at hand Schweinitz's specimens of Confervæ from North Carolina, and therefore can only present the following memoranda, which I made while examining them, some time since, in Dr. Torrey's herbarium. I give in one column the names attached by Schweinitz, and in the other the more modern names, where I have been able to determine them from the often unsatisfactory examination of the dried specimens.

Schweinitz's labels.		True name.
Conferva serpentinum, Salem, N. Ca.	=	*Conferva serpentinum*, Ag.?
" *fugacissima*, " "	=	" *floccosa*, Ag.
" *bipunctata*, " "	=	*Tyndaridea cruciata*, Harv.

Schweinitz's labels.				True name.
Conferva mutabilis,	Salem,	N. Ca.	=	*Draparnaldia glomerata*, Ag.
" *pectinalis*,	"	"	=	*Fragillaria pectinalis*, Lyngb.
" *lubrica*,	"	"	=	*Oscillatoria, sp.*
" *vaginata*,	"	"	=	*Microcoleus repens*, Harv.
" *genuflexa*,	"	"	=	*Mougeotia genuflexa*, Ag.
" *jugalis*,	"	"	=	*Zygnema quininum*, Ag.
" *fluitans*,	Schweinitz, Salem, N. Ca.			Not recognized.
" *amphibea*,	"	"	"	
" *setiformis*,	"	"	"	
" *varia*,	"	"	"	
" *semistrangulata*,	"	"	"	

It appears from the above, that to Schweinitz is due the credit of being the first to collect and study any of our fluviatile Algæ.

Hydrodictyon utriculatum, Roth. This most interesting plant was found by Dr. Paul B. Goddard and myself, growing abundantly in a small pond at the foot of Broad street, in Philadelphia, near the turn of the railroad. I kept living specimens for many months, and watched the singular method of reproduction. I also succeeded in sending living specimens to correspondents in London.

Mougeotia genuflexa, Ag. Providence, R. I. West Point, N. Y. Detroit, Michigan. Fort Winnebago, Ouisconsin.

Tyndaridea cruciata, Harv. Common in the Northern States. Also in Virginia.

Tyndaridea pectinata, Harv. Common with the above.

Zygnema nitidum, Ag. Waterville, Maine, to Culpepper Co., Virginia, and west to Ouisconsin.

Zygnema deciminum, Ag. Alabama, Dr. Gates! Very common with the above.

Zygnema quininum, Ag. Salem, N. Ca., Schweinitz! Common with the above.

If the numerous forms described and figured by Hassall, are really distinct species, the list of our species of Zygnema and Tyndaridea might be greatly extended, as I recognize among his figures many forms which are common in the United States, and which appear to me to be merely varieties of the above mentioned very polymorphous species.

Sphæroplea crispa, Berk. West Point, N. Y.

Vaucheria velutina. Shores of Hudson River, at West Point; in fruit in September. Shores of Seakonk River, near Providence, R. I.

Vaucheria cæspitosa, Salem, N. Ca., Schweinitz. Common at West Point, N. Y.; Waterville, Maine; Culpepper Co., Va.

Botridium granulatum, Grev. North Providence, R. I. West Point, N. Y. Very abundant on shores of small ponds, near the Ocean House, Newport, R. I.

Rivularia calcarea, Sm. Niagara Falls, on rocks wet with spray.

Rivularia atra, Roth. Rocky sea shores, Rhode Island. Rocks near low water, in the Hudson River, at West Point.

Rivularia angulosa, Roth. Common on leaves of Vallisneria in the Hudson River. Occurs also in Rhode Island, and in the Fourth Lake, Ouisconsin.

Stigonema atrovirens, Ag. Moist rocks at Indian Falls, Putnam Co., N. Y.

Stigonema mammilosum, Ag. Abundant in Round Pond, near West Point, covering submerged rocks, &c.

Scytonema ocellatum, Harv. Warden's Pond, R. I. Abundant at Niagara Falls, on rocks wet with spray.

Scytonema contextum, Carm. Foot of Crow's Nest, West Point.

Tolypothrix distorta, Kütz. Warden's Pond, R. I. Reservoir Pond, West Point. Fourth Lake, near Madison, Ouisconsin.

Calothrix confervicola, Ag. Very abundant on marine Algæ every where in Narragansett Bay, R. I.

Calothrix scopulorum, Ag. Rocks at Newport and Seaconnet, R. I.

Oscillatoria. The species of this genus are very difficult to identify by the descriptions, and it is even stated by Mayen, that many species undergo manifold changes during their growth. It is therefore with much hesitation that I present the following names.

Oscillatoria tenuissima, Ag. Warm Springs of Washita, Dr. James! v. sp. in herb. Tor.

Oscillatoria tenuis, Ag. Providence, R. I. West Point, N. Y. Culpepper Co., Va.

Oscillatoria decorticans, Grev. On pumps, &c. Common every where.

Oscillatoria muscorum, Ag. On mosses in the ravine on the Crow's Nest, West Point.

Oscillatoria nigra, Vauch. Common at West Point, N. Y.

Oscillatoria Corium, Ag. Mill dams near West Point.

All our species of Oscillatoria have a strong and peculiar swamp-like odor, which I have not seen alluded to by writers. Their extraordinary oscillations and radiations, so well described by Carmichael, (See Hooker's Brit. Flor., Vol. v, p. 372,) I have often witnessed, and I feel satisfied that it is impossible to account for these motions by evolutions of gases, currents in the liquid, elasticity of filaments, and other mechanical causes, which have been suggested by some writers in explanation of the phenomena.

Microcoleus repens, Harv. Common in damp earth. West Point, N. Y. Providence, R. I. Hingham, Mass., Rev. J. L. Russell!

Porphyra vulgaris, Ag. Narragansett Pier, S. T. Olney. Seaconnet, R. I. Massachusetts, G. B. Emerson and Rev. J. L. Russell!

Ulva latissima, Linn. Rhode Island. Common, Old Point Comfort, Va. Sullivan's Island, S. Ca.

Ulva lactuca, Linn. Rhode Island.

Ulva bullosa, Roth. Salem, N. Ca., Schweinitz. Newburgh, N. Y.

Merismopedia punctata, Meyen. Round Pond, near West Point. A larger variety occurs in freshwater pools, near the Pavilion, at Rockaway, Long Island, N. Y.

Bangia fusco-purpurea, Lyngb. Narragansett Pier, George Thurber! Newport and Seaconnet, R. I.

Enteromorpha intestinalis, Link. Hudson River, from Newburgh to New York city. Narragansett Bay, R. I. Common.

Enteromorpha compressa, Link. Common with the above.

Enteromorpha erecta, Hook. Newport and Seaconnet, R. I.

Tetraspora gelatinosa, Desv. Maine to Ouisconsin. Very common.

Tetraspora gelatinosa, var? *perforata*, Bailey. Perhaps a variety of the above, but remarkable for the numerous perforations in its pond. West Point, N. Y. Chautauque Co., N. Y., M. S. Petit!

Palmella hyalina, Lyngb. Rhode Island to Ouisconsin. Common.

Anabaina flos-aquæ, Bory. Round Pond, West Point. Hassall thinks that Bory's account of the ambulatory faculty, and vermiform motions of this curious organism, is "fanciful and overstrained." I have, however, frequently watched its active and extraordinary vermiform motions.

Protococcus nivalis, Ag. Red snow plant, forming red stains on gneiss rocks. Kosciusko's garden, in early spring.

Hæmmatococcus Grevillei? Ag. Common on summit of Crow's Nest, West Point, N. Y.

Nostoc foliaceum? Ag. Wet grounds near mill dams, &c. West Point, N. Y., and Providence, R. I.

Nostoc sphæricum, Vauch. Streams near West Point.

Nostoc cristatum, Bailey. A species apparently new, with flattened fronds resembling a cock's comb; occurs on stones in rivulets, near West Point. I have found it only late in autumn.

Since the publication of the first part of this list, I have referred some of our plants about whose true names I was in doubt, to the practised eye of the eminent British Algologist, W. H. Harvey, and I have to thank him for much useful information with regard to them, which although not sent with a view to publication, may I think be presented now without impropriety.

Laminaria? trilaminata, Harvey, MS. A curious three winged species, of which a fragment was found by Mr. Olney at Narragansett Pier, and of which I also found imperfect specimens at Stonington. Harvey remarks "it is new to me, and must be either a Laminaria or an Alaria, probably the former, but until perfect specimens are obtained we cannot decide."

Dictyosiphon fœniculaceus, Grev. Common at Newport and Seaconnet, R. I.

Gracilaria, n. sp. This species of Gracilaria grows in vast quantities in Narragansett Bay, near Providence, R. I. Harvey remarks concerning it, "it is new to me, and as far as I can make out undescribed. Agardh's Sphærococcus subulatus from Canada, seems to come nearest to it. It may be the same."

Chrysimenia, n. sp. Abundant near Providence, R. I. Harvey states, that "it is allied to C. clavellosa, but still more nearly to C. secunda, *Hook.* and *Harv.*, (a native of New Zealand,) and it may be identical with it."

Spyridia filamentosa, Harv. A slender variety of this, is the plant which I mistook for an undescribed species of Griffithsia. It occurs both at Providence and Newport.

Callithamnion corymbosum, Ag. Harvey thinks that the small Callithamnion common near Providence, is of this species, but he has not seen the fruit, which however I have studied myself on the recent plant, and I find it to agree with the description of C. corymbosum.

Polysiphonia Olneyi, Harv. MS. This beautiful plant grows in great abundance near Providence, R. I., where it was first found by S. T. Olney, Esq. of that city. I had confounded it with P. violacea, to which Harvey remarks it is very near but not exactly the same.

Polysiphonia variegata, Ag. fide Harv. Common near Providence, R. I.

Rhodomela subfusca, Ag. Common at Newport and Seaconnet Point, R. I.

Tetraspora perforata, Bailey. Harvey says, "this is certainly a new species. I have never seen any thing like it." It is common throughout the state of New York, and characterized by perforations of various sizes in all parts of the frond, so that when dried on paper it has a reticulated appearance.

(*To be continued.*)

ART. XLI.—*A few Remarks on the Silurian Classification;* by SIR RODERICK IMPEY MURCHISON, G. C. St. S., F. R. S., Memb. Imp. Acad. Soc. of St. Petersburg, Cor. of the Roy. Inst. France.

Belgrave Square, March 3, 1847.

TO THE EDITORS.

Gentlemen—I have sent to you, through your booksellers, a copy of my last memoir on the Silurian Rocks of Sweden, which may prove interesting to some of the American geologists on account of the distinctness which it establishes between the lower Silurian strata of the continent of Scandinavia and the isle of Oland, and the upper Silurian of the large island of Gothland, which I have placed in detailed parallel with our Wenlock and Ludlow rocks of England. In calling your attention, and that of your readers, to the concluding observations in that memoir, I must remind you, that when I wrote, I was arguing against a former proposition of my friend, Professor Sedgwick, viz: to subtract the Wenlock shale from the "upper," and add it to the "Lower Silurian;" and I then showed, that as my original division was founded on clear and typical districts of England, so it was equally applicable to Scandinavia, Russia and North America, where the beds with small Pentameri beneath the Wenlock shale, seemed to form the upper horizon of the lower Silurian division. Since that period, my able coadjutor, M. de Verneuil, has been among you, and after traversing large districts of your country, and inspecting many of your museums, has satisfied me that the broad divisions of lower and upper Silurian are clearly recognizable in North America, as so well developed, indeed, by your own authors. Again, in Europe, Bohemia has been described by M. B*———, to contain (particularly around Prague) a very symmetrical Silurian basin, composed of upper and Silurian rocks, loaded with characteristic fossils, among which are species of trilobites, the lowest fossiliferous beds resting on slaty grauwacke, without fossils, to which the author applies the term Cambrian.

I call your notice to this last mentioned fact, (intending to visit Bohemia in company with M. de Verneuil, in the ensuing summer,) because I have, in the course of this winter, been compelled for the first time to defend my "Lower Silurian" against a new proposal of Professor Sedgwick, which almost amounts to the suppression of the term, and the substitution, in its place, of the word "Cambrian." To this proposition I am entirely opposed. The latter term was suggested a year after I gave my first general view of the upper and lower Silurian rocks (in 1835) as forming one natural system, and the word Cambrian was afterwards

* The MS. did not enable us to ascertain this name.

applied to the masses lying beneath the "Lower Silurian," which might be found to be characterized by a distinct group of organic remains. Subsequent researches, however, in various parts of Europe and America, have shown that no typical fossils can be detected in any of the lower strata differing from those by which I characterized the lower Silurian, and hence, on the principle of "strata identified by fossils," I have for some years past maintained, in all my publications, that the base line of the Silurian rocks so descended as to embrace the earliest clear traces of organic life. The government geologists of Britain, under Sir Henry De la Beche, have pointed out, that throughout South Wales, the very strata which I had described as "Lower Silurian," fold over and over, and occupy large tracts, to which I had, in my first work, erroneously applied the word "Cambrian;" and now these same surveyors, particularly Mr. Ramsay and that able palæontologist, Professor Edward Forbes, assure me, that throughout all North Wales, from Bala to Snowden, the rocks which I had hoped might be typified by other or "Cambrian" fossils, are charged with the same lower Silurian forms, and often with the very same species which are described by me as occurring in my Carodoc sandstone or Llandeilo Flags. They further confirm my original views of classification, in stating that these North Welsh strata, whether lower or upper Silurian, are so linked together, that they form one natural system; there being found many more species common to the upper and lower division than I had been able to detect, when I completed the Silurian system, in 1839.

Now, whilst my memoir on Gothland demonstrates the identity of its upper Silurian functions with those of Britain, the labors of our government geologists are daily opening out new features of comparison between the "Lower Silurian" of Russia and Scandinavia, as described by de Verneuil, Keyserling and myself, and the North and South Welsh strata. Thus the *Cystidea*, those earliest forms of Crinoids, with which I was unacquainted when the Silurian system was published, and which occur in myriads in the lower Silurian limestone around the Baltic, have been found pretty abundantly near Bala, Harefordwest, &c.; and among them is the very species, *Echino-sphærites (Sphæronites) aurantium*, which abounds in Russia and Sweden. It follows, therefore, that the terms which I was the first to propose must be adhered to, particularly as I have myself applied them to very large regions of Europe, on fair inductive evidence, and that North American geologists have honored me by doing the same in their country.

Again, whilst no zoologist has attempted to define any distinct types of life of earlier date than the lower Silurian, so is it impossible (at least in any region which I have seen) to separate

that group physically from the upper Silurian, by any line of general dislocation. If the lower Silurian rocks in America were unconformable to the upper, then it might be contended by those geologists who look rather to great physical phenomena than to organic life, that the Cambrian was one epoch and the Silurian another. But such is not the fact. In North Wales, as in other parts of Europe, the upper and lower Silurian fold over in conformable masses, and the lines of dislocation in that broken and porphyritic region run at one place through parts of the upper, and in others in the inferior fossil beds. There are, it is true, certain tracts, particularly that of the Longmynd in Shropshire, described by me in the year 1835,* where certain lower Silurian strata abut against and repose unconformably on very ancient grauwacke, without fossils, and the same may be said of a limited tract of inferior grauwacke, near St. Davids. To such rocks, lying *unconformably* beneath strata charged with lower Silurian fossils, the term Cambrian may be applied, and in the process of research some few and, perchance, peculiar organisms may be found in them. But I distinctly maintain that the so called Cambrian never having been characterized by any published fossils, cannot now be created into a system at the expense of the larger part of my well recognized and long established Silurian system, the more so as I am supported by every naturalist who has studied the subject, in the opinion that the upper and lower Silurian constitute one natural series only. This view is every day strengthened by new discoveries. Only a few months ago, I firmly believed, that as no remains of vertebrata had been detected in the lower Silurian rocks of any part of the world, there was a period when other classes of marine animals abounded in the seas, without being accompanied by fishes. But I now learn from Prof. E. Forbes, that the defence of an Onchus has been found in the lower Silurian rocks, near Bala; whilst it appears that Professor Sedgwick and his companions detected last summer a similar fragment in true Llandeilo flags. It is therefore proved that the same genus Onchus, which Agassiz first described for me from the fish bed of the Ludlow rocks,† is now found to range down into the lower Silurian; and as rare portions of ichthyolites have also been found in the intermediate strata of Wenlock shale, &c., I willingly correct a generalization which I attempted, in declaring my belief that the lower Silurian was an invertebrate period. My eminent friend Agassiz, who is now making himself as beloved and admired in the United States, as in England and other countries he has visited, has thus in the end been borne out by the new discoveries. For, whilst I reasoned

* Phil. Mag., June, 1835.

† See Silurian System, page 256, *et seq.*

mainly on the fact that no remains of fishes had ever been found in lower Silurian rocks, among the countless myriads of other marine animals, and that I was also influenced in my views by the proofs afforded by geological enquiry of a progression in creation, Agassiz has proved right in his conjecture that with such associates, fishes would sooner or later be detected. In one respect, indeed, I rejoice in the discovery, as the occurrence of an Onchus in upper Ludlow rocks and in Llandeilo flags, unites with other palæontological evidences to bind all the Silurian rocks together in one natural system.

In conclusion, I would observe that whilst it is impossible, for the reasons above cited, to admit that the Silurian system can be broken into two systems, I might convince you, by another method of reasoning, that the adoption of such a proposition would entirely destroy the very term Silurian, in reference to regions of the continent of Europe, to which it has been applied, such as large parts of Russia, Scandinavia, &c., where the lower Silurian alone is developed. But I have already said more than enough, and will only add, that notwithstanding our recent animated discussions, Professor Sedgwick and myself have still as warm a friendship for each other as ever, and however he may ultimately persist in calling certain rocks of North Wales "Cambrian," (although they are loaded with true lower Silurian fossils,) I must seize this opportunity of declaring that I consider this to be little more than a geographical distinction; and further, I must express my belief that if he should produce a work upon the geological structure of the old and slaty tracts of Britain, upon which he has been long occupied, it will be found to be in every way worthy of his deservedly high reputation, and will throw important new lights on those parts of geological science which his eloquence and memoirs have already adorned.

ART. XLII.—*Hydrate of Nickel, a New Mineral;* by Prof. B. SILLIMAN, Jr.

THIS mineral occurs incrusting the surface of chromic iron from Texas, Lancaster County, Pennsylvania, and has been circulated among American mineralogists during the past year, under the name of green oxyd of chrome. I found it, however, on analysis, to be a hydrous green oxyd of nickel nearly pure. It is found in lustrous emerald green crusts, on the surface of some specimens of the chrome iron from these mines; rarely in stalactites and columnar masses. It is often covered with a thin coating of carbonate of lime or magnesia which obscures its color. Alone it is quite transparent and of the most brilliant emerald green color. Hardness 3 or 3·25, being a little above calc spar. Gravity 3·0523,

as taken in small fragments with the specific gravity bottle. Its lustre is highly vitreous and its fracture uneven and scaly. It is extremely brittle and is readily pulverized, giving a light yellowish green powder; it is very easily detached from the gangue on which it rests. Its pyrognostic character is perfectly decisive. Alone in a close tube it affords a copious yield of water, which is neutral to test paper; and it loses its fine color at a temperature but little above 212°; with a higher heat it becomes blackish gray and is then quite unchanged by long continued heat. An empyreumatic odor is also found in the tube when it is heated. It forms no bead with carbonate of soda in either flame of the blowpipe; with borax, it readily fuses into a transparent bead, of a dark yellow or reddish color when hot, and nearly colorless when cold. In the reducing flame, with a larger quantity of the mineral, the bead becomes gray and opake from the presence of numerous particles of finely divided metallic nickel which cannot, by long blowing be fused into a bead. On crushing this borax glass in an agate mortar under water, a gray powder appears, which is strongly attached by the magnet, and which burnishes under the pestle, showing the reddish white color of metallic nickel. With salt of phosphorus its behavior is precisely like the artificially prepared oxyd of nickel. An examination in the wet way detected only trifling traces of oxyd of iron and perhaps alumina. It dissolves completely and with very slight heat in dilute chlorohydric acid, and the few black particles which collect on the bottom of the flask are minute flakes of chrome iron mechanically entangled in the mineral. The solution has the fine grass green tint which belongs to the salts of nickel. Sulphuretted hydrogen produces no turbidness in the solution, and no traces of oxyd of chrome could be detected. Indeed the blowpipe decisively indicates the absence of this oxyd, since an exceedingly small trace would give the borax glass its characteristic green tint when cold. The beautiful green color of this mineral, as found, led no doubt to the supposition that it was the native green oxyd of chrome, which seemed a plausible conjecture. Its water was determined by ignition of a weighed quantity of the mineral in a carefully counterpoised platinum crucible, cooling after ignition in a desiccator over sulphuric acid. It lost as the mean of four trials 38·50 pr. ct. of water, which is rather more than two atoms. Its constitution will probably be correctly expressed by $\dot{N}i2\dot{H}$. It will be remembered that the artificial hydrate of nickel prepared by precipitation with potash from the nitrate is $\dot{N}i\,\dot{H}$ or only one atom of water.

The discovery of the composition of this mineral led me to examine the composition of several specimens of carbonate of magnesia from the same mines, which have a green tint more or less

deep. I found in all of them the oxyd of nickel, in quantity proportioned to the depth of color of the specimen. In some of them, the green color seems to be an exterior coating and in others to penetrate the mass uniformly. These specimens of carbonate of magnesia are not crystallized although they appear to be so, but are only a congeries of little spherical grains about $\frac{1}{180}$ of an inch in diameter, which are cracked in radii from the centre. The same appearance, resembling aggregations of crystals, I have observed in one specimen of the hydrate of nickel which led me at first to suppose that I had found it crystallized. The constitution of the chrome iron on which this new mineral is found, now becomes an interesting inquiry. I owe these and many other interesting minerals from the same region, to Mr. L. W. Williams, of Westchester, Pa.

NOTE.—Since these observations were made, I have seen a mention in the Proceedings of the Boston Nat. Hist. Soc., Nov. 18, 1846, from Dr. Jackson, of "a green crust, which he supposed to be a new mineral, adhering to a mass of chrome ore." This mineral, as I learn from Dr. Jackson, is from the same mines as the one described in the foregoing article, and is undoubtedly the same species.

New Haven, March 30th, 1847.

ART. XLIII.—*On Cupellation with the Blowpipe*; by WILLIAM W. MATHER.

A NOTICE of a new mode of cupellation on mica with the blowpipe, was published by me in this Journal, vol. xxxv, p. 321. A writer has subsequently in vol. xlii, p. 394, mentioned another equally simple, which was taught him by Prof. H. Rose of Berlin. That method consists in pressing moistened pulverized bone ash into cavities in charcoal, and cupelling on that. If the surface of the cupel be not very smooth, almost polished, the grain of silver, if very small, will disappear in the pores of the cupel, or be buried in the excrescences of its surface. This method of cupellation, and that on small cupels, have been long in use and are well known. The bone ash cupels have the advantage of absorbing the oxyd of lead as fast as formed; but they have the disadvantage of absorbing some silver with the litharge. This is a serious inconvenience where a strict quantitative determination of the silver is desired. This may be obviated to a great extent on mica, by keeping the oxydizing metal more or less immersed in the fluid oxyd. When bone earth cupels are used, the globule of lead when reduced to a very small size, should be put upon a fresh cupel, or on a clean place on the one in use, where the surface is very smooth, else if the globule of silver or gold be very small, it will not appear.

When the cupellation is performed on mica, the oxydation is nearly as rapid as on the bone ash cupel, and the globule is kept partially immersed in the melted oxyd of lead, and thus the silver that would otherwise be lost in the litharge, is mostly taken up by the lead.* A little skill in the operator will enable him when the oxyd has accumulated to some extent around the globule of lead, to slide the melted globule by a slight inclination to another place, without losing it off from the mica. This obviates in a great degree the loss of time, that would otherwise arise from the necessity of cooling to detach the globule, put it in a new place and heat it again to the proper temperature. When the cupellation globule is reduced to the size of a mustard seed, whether bone ash or mica be used for cupelling, it is well to remove it to a new very smooth cupel, or to a fresh piece of good mica, and then, when melted, make the globule slide by inclining the cupel, and by means of the blast, to fresh surfaces, until, finally, the globule of silver or gold remains pure, or as nearly so as cupellation will make it. No silver is lost in this way, except the extremely minute quantity carried off in the litharge, and that which is vaporized if the heat be too high.

The method of cupellation on mica I consider more accurate than that on bone earth, and if the mica be of good quality, so as not to exfoliate at all by heat, or permit the litharge at the proper temperature to pierce it, globules of $\frac{1}{1,000}$, $\frac{1}{2,000}$, $\frac{1}{3,000}$ grain in weight may be seen on its surface by the naked eye. When good mica cannot be obtained, I use bone earth cupels made compact, smooth, almost polished, flat and discoidal in form, about the size of a wafer and $\frac{1}{20}$ to $\frac{1}{14}$ inch thick. These answer for the last part of the operation of cupelling nearly as well as the mica. Mica is more portable than cupels, or the materials of which cupels are made, and when the surface becomes loaded with oxyd, a thin scale can be split off and leave the surface fresh and ready for new cupellations. The difficulties of this mode of cupellation are, lack of skill in manipulation, and the difficulty of getting the right quality of mica. The advantages are, 1st. avoiding nearly all the loss of silver that is usually carried off by the litharge, and 2d. greater accuracy in the results of quantitative cupellation. It is generally supposed that the detection and quantitative estimation of silver in solution by means of chlorohydric acid in a dilute solution, was more certain than cupellation. I do not find it to be so, but cupellation properly conducted, will not only detect silver, but afford quantitative results, where the most refined methods of analytical research fail to give any indication of its presence. I have found it impracticable, thus far, to obtain

* This is the explanation of the well known fact that the cupellation of lead in the large way, always gives a larger yield of silver, than is indicated by cupellation in the small way on bone ash cupels.

lead entirely free from silver. The German granulated lead prepared expressly for this purpose, contains a notable quantity of silver. Nitrate of lead and acetate of lead when reduced and cupelled yield silver; and I have precipitated lead with zinc, rejecting the half of the lead first precipitated, as being that likely to contain all the silver, and saving only that part precipitated last, and still found it to contain silver. As lead absolutely pure seems to be unattainable, I estimate the difference between the weights of cupellation globules, obtained from the metal or ore, and from an equal quantity of lead cupelled alone of the same kind as that used in the cupellation.

The buttons or cupellation globules of silver or gold, vary in magnitude in lead, lead ores, &c., as usually cupelled with the blowpipe, from $\frac{1}{10}$ grain to $\frac{9}{m}$. It is comparatively rare that their weights can be correctly appreciated, even by our best balances. I use two methods of appreciating their weights.

(1.) By having a series of cupellation globules of known weights from $\frac{1}{10}$ grain down to $\frac{1}{10\,0\,0\,0}$ grain,* and by means of a microscope, comparing the diameter of the cupellation globule with those of known weight. This method by means of a good micrometer microscope affords approximations to truth, more to be relied on than the balance, when the globules are small.

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* These weights are easily made by a little skill in manipulation. To make moderately small weights I have used silver lace, which when unravelled, is a silk thread wound with flattened wire of silver of great tenuity. I found how many inches of this gave 1 grain of silver, and then by means of dividers and a sector scale, cut off such lengths as would make $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. grains. With the sector scale, $\frac{1}{100}$ and even $\frac{1}{200}$ of an inch can be measured. One hundred and twenty inches in length of the lace, gave 2·2 grains of silver. Twelve inches = ·22 grain, 1·2 in. = 0·022 grain, 0·12 in. = 0·0022 grain, &c., and generally, 120 in. : 2·2 grs. :: x length required : y the weight required. If $y = \frac{1}{1000}$ grain, then 120 in. : 2·2 :: $x : \frac{1}{1000}$ $\therefore x = \frac{1\cdot2}{220}$ inch, which is easily laid off on the sector scale. Having the length cut off, moisten it with borax water and melt on charcoal. The borax water enables the silver to coalesce without separating into several globules, as it would do, if it was not thus moistened and rolled up into a little pellet. The borax is so small in quantity, where the thread is moistened with borax water, that it does not dissolve any sensible quantity of silver. By rolling the moistened thread into a little pellet, I can easily make all the silver coalesce into a single globule when the thread is ten to twenty inches in length.

For still smaller weights I use fine plated copper wire, and cupel it. That used is from an epaulette, of which by careful analysis, I found 1800 feet in length gave 16 grains of silver, = 1350 inches in length for 1 grain of silver. 13·5 inches then would give $\frac{1}{100}$ grain of silver; 1·35 inches = $\frac{1}{1000}$ grain of silver, and 0·135 inch = $\frac{1}{10\,0\,0\,0}$ gr. of silver. This is not strictly accurate, for a little of the silver is lost by the litharge and by vaporization, and a little gained from the lead used in cupellation of the wire. Still, it is sufficiently accurate for use.

For gold weights of comparison, I have used Wollaston's method; enclosing a very delicate wire of gold in a very coarse silver wire, with a hole drilled to let the gold wire in, and then drawing down the silver to its limit, and dissolving the silver by nitric acid, leaving the gold almost as fine as spider's web thread. Then ascertain how many yards weigh a grain, lay off and cut off the lengths for the required weights, and melt into a globule.

(2.) I use also the principle of Harkort's scale,* in measuring the diameters of minute cupellation globules, but applied somewhat differently. In most of the boxes of French mathematical drawing instruments, a brass sector scale is found, which when closed, shuts so as to leave, if well made, a junction that is a mere line to the eye. From the centre of motion, a line is drawn on each arm of the scale six inches in length, divided into two hundred equal parts, and when the scale is completely closed, the two hundreth equal part at the end of one of these lines, is exactly one inch from the two hundreth equal part at the end of the other line.†

If we wish to measure the diameter of cupellation globules, less than $\frac{1}{4}\frac{1}{0}$ inch in diameter, (and most blowpipe globules are smaller,) measure one inch between the points of the dividers, and set their points in the equal parts marked 195; (for $\frac{1}{4}\frac{1}{0}$ inch $= \frac{5}{2}\frac{5}{0}\frac{5}{0}$ and $200 - 5 = 195$.) The arms of the sector scale between the points marked 200 are then $\frac{1}{4}\frac{1}{0}$ inch apart, and approach each other to the centre of motion, where their distance $= 0$. In this way the scale may be set to any fraction less or greater than an inch that may be desired. The cupellation globule is laid between the diverging arms of the scale, and slidden along by a pin or other convenient instrument, until the globule *falls in* between the arms of the scale. The width of the opening between the arms at this point, gives the diameter of the globule. Suppose the scale set to measure globules between $\frac{1}{4}\frac{1}{0}$ inch and 0, and the globule falls in opposite the equal parts marked 45. The diameter of the globule is then $\frac{4}{2}\frac{5}{0}\frac{5}{0}$ of $\frac{1}{4}\frac{1}{0} = \frac{4}{2}\frac{5}{0}\frac{5}{0} = \frac{1}{2}\frac{1}{7}\frac{1}{7}$ inch.

A globule of silver of $\frac{1}{2}\frac{1}{7}\frac{1}{7}$ inch in diameter weighs about 0·00006 grain. This weight is about $\frac{1}{9}$ more than the actual weight of a cupellation globule of that diameter, because the above is calculated for a *sphere* of silver, and the cupellation globules are always more or less *flattened* on the lower side, unless they are extremely minute. A globule of silver $\frac{6}{1}\frac{6}{0}\frac{6}{0}$ inch diameter, if a sphere, would weigh 0·298665 grains; but owing to the flattening of the cupellation globule, the actual weight of one of that diameter is only 0·18 grains, or about $\frac{3}{8}$ less. I do not generally permit myself to estimate the weights of cupellation globules by their diameters when greater than $\frac{1}{4}\frac{1}{0}$ inch diameter, in consequence of the rapid variation in the law of the relative weights to the diameters, and globules above that size can be as correctly appreciated by a good balance. The eye can generally unaided by a magnifier see a globule of silver of $\frac{1}{1}\frac{1}{0}\frac{1}{0}\frac{1}{0}$ inch diameter, which weighs about $\frac{1}{1}\frac{1}{0}\frac{1}{0}\frac{1}{0}\frac{1}{0}\frac{1}{0}\frac{1}{0}$ grain, and this can be

* Vide Whitney's edition of Berzelius on the Blowpipe, p. 104.

† A similar method of mensuration will be found in the Appendix to Muspratt's translation of Plattner's work on the blowpipe, by Prof. O. Byrne.—*Eds.*

measured with considerable accuracy by means of a micrometer microscope. This degree of accuracy is sufficient for all practical purposes, for if ten grains of lead only gave $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$ grain of silver, 312½ tons would be required to produce one oz. of silver. If ten grains of lead or rather alloy cupelled yield $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$ grain of silver or $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$ of its weight, it would contain only 3½ oz. per ton, or if it yielded $\frac{1}{1000}$ grain, it would be 32 ounces of silver per ton of lead or alloy.

Means of estimation like those mentioned are sufficiently accurate for practical purposes, by using one grain weight of the alloy or one mixed with a suitable quantity of lead.

Quantities of silver far more minute can be detected by suitable care in blowpipe cupellation. With a good microscope a globule of silver $\frac{1}{2000}$, $\frac{1}{10000}$ inch diameter ought to be visible, which would weigh about $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$ of a grain.* A metal that would yield this minute quantity of silver or gold from the weight of one grain would require 5,000,000 tons to produce one pound of silver or gold.

The above theoretical limit of mensuration is perhaps also about the practical limit of detection of silver and gold in bodies suspected to contain them, in consequence of the volatility of these metals at a high temperature in a current of air, and the litharge taking away some. In cupellation the heat should never be raised above a high red heat, until just before the *lightening* of the metal, and then only for an instant, else there will be a loss of silver or gold.

To save trouble in estimating the weights of cupellation globules, a table is subjoined, and the weights of globules of several diameters are indicated, supposing them to be spheres. A deduction of about one-fourth should be made in globules from $\frac{1}{20}$ to $\frac{1}{40}$ of an inch in diameter, about one-fifth in those from $\frac{1}{40}$ to $\frac{1}{60}$, about one-sixth in those from $\frac{1}{60}$ to $\frac{1}{100}$, about one-seventh in those from $\frac{1}{100}$ to $\frac{1}{150}$, about one-eighth in those from $\frac{1}{150}$ to $\frac{1}{200}$. Those smaller than $\frac{1}{200}$ inch scarcely differ from a sphere.

The weights of spheres of gold or silver of any other diameters than those in the table, are easily calculated by the formula $W = CD^3$. C is a constant for the same metal, and represents the weight of a sphere of the metal one inch in diameter. This weight

* For 1 cubic inch of distilled water weighs 252·46 grains. If the specific gravity of silver be called 10·5, then 1 cubic inch of silver would weigh 252·46 grains × 10·5 the sp. gr. of silver = 2640·8 grains. Solids are proportional to the cubes of their like linear dimensions. An angle of 1″, the limit of the visual angle, at a distance of 8 inches subtends $\frac{8}{2000,000}$ of an inch, $= \frac{1}{250000}$ inch. ∴ $(1 \text{ inch})^3 : (\frac{1}{250000})^3 :: 2640{\cdot}8 \text{ grains} : x = \frac{2640{\cdot}8}{15625{\cdot}000{\cdot}000{\cdot}000{\cdot}000} = \frac{1}{5916767676} =$ about one six thousandth million of a grain, or in a spheroid form, a globule of about one ten thousand millionth of a grain. Small globules may be rendered more distinct by pressure in an agate mortar, which not only gives them a greater area, but a much greater reflecting surface.

for gold is 2577·667 grains, and for silver 1382·72248 grains.* D represents any diameter whether a whole number or fraction, and W the weight required. Logarithms are easily applied, and save much labor. Log. W = log. C + 3 log. D.

Table exhibiting the Weights of Spheres of Gold and Silver of varied diameters, of fractions of an inch.

Diameters of spheres in inches.		Parts on sector scale set to $\frac{1}{20}$ inch.	Weights of spheres expressed in grains.		Diameters of spheres in inches.		No. of equal parts on sector scale open $\frac{1}{20}$ inch.	Weights of spheres expressed in grains.	
Decimals.	Vulgar fr.		For gold.	For silver.	Decimal fractions	Vulgar fractions		For gold.	For silver.
1·000	1	. .	2577·667	1382·7224	·072	$\frac{1}{13\frac{8}{9}}$	29	0·0009808	0·0005261
0·100	$\frac{1}{10}$	. .	2·57766	1·382722	·069	$\frac{1}{14\frac{3}{9}}$	28	0·0008814	0·0004728
0·080	$\frac{1}{12\frac{1}{2}}$	. .	1·31975	0·70656	·067	$\frac{1}{14\frac{8}{9}}$	27	0·0007951	0·0004265
0·0625	$\frac{1}{16}$	. .	0·62931	0·33757	·065	$\frac{1}{15\frac{3}{9}}$	26	0·0007197	0·0003860
0·0600	$\frac{1}{16\frac{2}{3}}$	. .	0·55677	0·29866	·062	$\frac{1}{16\frac{0}{9}}$	25	0·0006293	0·0003375
0·0500	$\frac{1}{20}$	200	0·32221	0·17284	·060	$\frac{1}{16\frac{6}{9}}$	24	0·0005635	0·0003022
0·0400	$\frac{1}{25}$	170	0·16497	0·088494	·057	$\frac{1}{17\frac{3}{9}}$	23	0·0004978	0·0002670
0·0300	$\frac{1}{33}$	121	0·069618	0·037333	·055	$\frac{1}{18\frac{1}{9}}$	22	0·0004347	0·0002331
0·0250	$\frac{1}{40}$	100	0·040276	0·021605	·052	$\frac{1}{19\frac{0}{9}}$	21	0·0003758	0·0002015
0·0200	$\frac{1}{50}$	80	0·020611	0·011061	·050	$\frac{1}{20\frac{0}{9}}$	20	0·0003222	0·0001728
0·0166	$\frac{1}{60}$	66·6	0·011934	0·0064015	·047	$\frac{1}{21\frac{0}{9}}$	19	0·0002783	0·0001493
0·0160	$\frac{1}{62\frac{1}{2}}$	64	0·010557	0·0059305	·045	$\frac{1}{22\frac{2}{9}}$	18	0·0002355	0·0001263
0·0142	$\frac{1}{70}$	57	0·007515	0·0040312	·042	$\frac{1}{23\frac{8}{9}}$	17	0·0001986	0·0001065
0·0133	$\frac{1}{75}$	53	0·006110	0·0032775	·040	$\frac{1}{25\frac{0}{9}}$	16	0·0001649	0·0000884
0·0125	$\frac{1}{80}$	50	0·005034	0·0027006	·037	$\frac{1}{26\frac{6}{9}}$	15	0·0001368	0·0000734
0·0119	$\frac{1}{83\frac{1}{3}}$	48	0·004474	0·002400	·035	$\frac{1}{28\frac{5}{9}}$	14	0·0001113	0·0000597
0·0117	$\frac{1}{85}$	47	0·004295	0·002251	·032	$\frac{1}{30\frac{7}{9}}$	13	0·0000890	0·0000477
0·0111	$\frac{1}{90}$	44	0·003535	0·001896	·030	$\frac{1}{33\frac{3}{9}}$	12	0·0000682	0·0000374
0·0105	$\frac{1}{95}$	42	0·003006	0·001612	·027	$\frac{1}{36\frac{3}{9}}$	11	0·0000538	0·0000289
0·0100	$\frac{1}{100}$	40	0·002577	0·001382	·025	$\frac{1}{40\frac{0}{9}}$	10	0·0000402	0·0000215
0·0097	$\frac{1}{102\frac{1}{2}}$	39	0·002393	0·001283	·020	$\frac{1}{50\frac{0}{9}}$	8	0·0000206	0·0000110
0·0095	$\frac{1}{105}$	38	0·002226	0·001194	·016	$\frac{1}{60\frac{0}{9}}$	6·6	0·0000119	0·0000064
0·0093	$\frac{1}{107\frac{1}{2}}$	37	0·002075	0·001113	·014	$\frac{1}{70\frac{0}{9}}$	5·7	0·0000075	0·0000040
0·0091	$\frac{1}{110}$	36	0·001936	0·001038	·012	$\frac{1}{80\frac{0}{9}}$	. .	0·00000503	0·00000269
0·0088	$\frac{1}{112\frac{1}{2}}$	35·7	0·001810	0·000971	·011	$\frac{1}{90\frac{0}{9}}$	. .	0·00000353	0·00000189
0·0087	$\frac{1}{115}$	35	0·001694	0·000909	·010	$\frac{1}{100\frac{0}{9}}$	. .	0·00000257	0·00000138
0·0083	$\frac{1}{120}$	33·3	0·001491	0·000800	·008	$\frac{1}{120\frac{0}{9}}$	. .	0·00000149	0·00000079
0·0080	$\frac{1}{125}$	32	0·001319	0·000707	·006	$\frac{1}{160\frac{0}{9}}$	. .	0·00000062	0·00000033
0·0077	$\frac{1}{129}$	31	0·001200	0·000644	·005	$\frac{1}{200\frac{0}{9}}$	. .	0·00000032	0·00000017
0·0075	$\frac{1}{133}$	30	0·001095	0·000587	0·002	$\frac{1}{250\frac{0}{9}}$	. .	0·00000016	0·00000008

Jackson C. H., Ohio, March 3d, 1847.

* It has been shown in a preceding note, that a cube of silver of 1 inch, would weigh 2640·8 grains. The sphere of the same diameter would weigh 2640·8 × 0·5236 = 1382·72248 grains. The cube of gold of one inch, weighs 4922·97 grains, and a sphere of the same weighs 2577·667. The contents of a cube : that of an inscribed sphere, :: 1 : 0·5236, for the contents of a sphere = $\frac{4}{3}\pi R^3$ = when the diameter is unity, $\frac{4}{3}\pi(\frac{1}{2})^3 = 0·5236$.

ART. XLIV.—*On the Variation of a Differential Coefficient of a Function of any number of Variables;* by A. D. STANLEY, Professor of Mathematics in Yale College.

WHEN a quantity is a function of a *single* variable, the *variations* of its differential coefficients are, as is well known, easily determined. But the variations of differential coefficients of a function of *two* variables have not been ascertained without difficulty. Lagrange, the inventor of the Calculus of Variations, never obtained them by a method duly general. Poisson was the first to do this; which however has since been done in a somewhat simpler manner by Mr. Ostrogradsky. But for the *general* case in which we have any number of independent variables, or even for the third case in point of complexity, viz. that in which *three* variables are concerned, the variations in the differential coefficients of a function have not been determined by either of these analysts. To obtain them by the complex methods which they used in dealing with two variables, would be extremely difficult, if not quite impracticable. Indeed Poisson never undertook to extend his investigations beyond the case in which two variables are concerned. Mr. Ostrogradsky, however, abandoning the method which he had pursued successfully in the case of two variables, attempted by a simpler process to determine the variations in question for the general case in which the variables are of any number whatever. But the attempt was unsuccessful, as must we think be evident on carefully examining the principle that is made the basis of his investigations; which is, that the variation of the differential of a function is equal to the differential of the variation of the function; or to state the principle in algebraic language, $\delta d\mathrm{V} = d\delta\mathrm{V}$. (That this statement is inadmissible, we shall, at another time, attempt to show.) There is however an article on the Method of Variations by Mr. Pagani, published in the fifteenth volume of Crelle's Mathematical Journal, that contains a correct solution, and, as is believed, the only one yet given, of the general problem we speak of. Before meeting with the investigations of Mr. Pagani and Mr. Ostrogradsky, the writer of this article had fallen upon two different methods of procedure, each of which leads directly to a solution of the problem under view, in its most general form. The principles employed in one of them are the same substantially as appear in that of Pagani; though this may not be readily perceived, as we use them in a manner considerably different from his. But the other method is essentially different, and is much more simple and concise. Still as the problem concerned is of fundamental importance in the Calculus of Variations, it may not be useless to state the former as well as the latter method of solution.

Let then $u=f(x, y, z, \&c.)$, and by *variation* let this equation become $\mathrm{u}=\mathrm{f}(\mathrm{x}, \mathrm{y}, \mathrm{z}, \&c.)$: also let $\delta u=\mathrm{u}-u$, $\delta x=\mathrm{x}-x$, $\delta y=\mathrm{y}-y$, $\delta z=\mathrm{z}-z$, &c. δu, δx, δy, δz, &c. being functions of all the independent variables, x, y, z, &c. These variations being *assumed*, our object is to determine the *resulting* variations in the differential coefficients of u; as for instance, the variation of $\frac{du}{dx}$.

Now by reason of the variations assumed, $\frac{du}{dx}$ becomes $\frac{\mathrm{du}}{\mathrm{dx}}$: the variation of $\frac{du}{dx}$ therefore, is $\frac{\mathrm{du}}{\mathrm{dx}}-\frac{du}{dx}$; and if this be denoted by $\delta\frac{du}{dx}$, we have the equation $\delta\frac{du}{dx}=\frac{\mathrm{du}}{\mathrm{dx}}-\frac{du}{dx}$: but $u=\mathrm{u}-\delta u$; hence,

$$\delta\frac{du}{dx}=\frac{d\mathrm{u}}{d\mathrm{x}}-\frac{du}{dx}+\frac{d\delta u}{dx}.$$

Now

$$\frac{d\mathrm{u}}{d\mathrm{x}}=\frac{d\mathrm{u}}{d\mathrm{x}}\frac{d\mathrm{x}}{dx}+\frac{d\mathrm{u}}{d\mathrm{y}}\frac{d\mathrm{y}}{dx}+\frac{d\mathrm{u}}{d\mathrm{z}}\frac{d\mathrm{z}}{dx}+\&c.$$

and $\frac{d\mathrm{x}}{dx}=\frac{d(x+\delta x)}{dx}=1+\frac{d\delta x}{dx}$, $\frac{d\mathrm{y}}{dx}=\frac{d(y+\delta y)}{dx}=\frac{d\delta y}{dx}$, $\frac{d\mathrm{z}}{dx}=\frac{d\delta z}{dx}$=&c. Hence, $\delta\frac{du}{dx}=\frac{d\delta u}{dx}-\frac{du}{d\mathrm{x}}\frac{d\delta x}{dx}-\frac{du}{d\mathrm{y}}\frac{d\delta y}{dx}-\frac{du}{d\mathrm{z}}\frac{d\delta z}{dx}$-&c. and if we consider that $\frac{d\mathrm{u}}{d\mathrm{x}}=\frac{du}{dx}+\delta\frac{du}{dx}$, and* neglecting the infinitesimal $\delta\frac{du}{dx}$, substitute $\frac{du}{dx}$ for $\frac{du}{d\mathrm{x}}$, and substitute also $\frac{du}{dy}$, $\frac{du}{dz}$, &c. for $\frac{du}{d\mathrm{y}}$, $\frac{du}{d\mathrm{z}}$, &c. we obtain the equation

$$(1.)\qquad \delta\frac{du}{dx}=\frac{d\delta u}{dx}-\frac{du}{dx}\frac{d\delta x}{dx}-\frac{du}{dy}\frac{d\delta y}{dx}-\frac{du}{dz}\frac{d\delta z}{dx}-\&c.$$

This is easily reducible to the following form, which will be found convenient for purposes of generalization;

$$\delta\frac{du}{dx}=\frac{d}{dx}\left(\delta u-\frac{du}{dx}\,\delta x-\frac{du}{dy}\,\delta y-\frac{du}{dz}\,\delta z-\&c.\right)$$
$$+\frac{d^2u}{dxdx}\,\delta x+\frac{d^2u}{dxdy}\,\delta y+\frac{d^2u}{dxdz}\,\delta z+\&c.\ \text{or}$$

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* The objections to which this mode of reasoning, so common in the Calculus, is liable, may be obviated by regarding the sign = as indicating, not that the two quantities on opposite sides of it are equal, but that the limit of their ratio is unity; and we doubt whether it is possible to present the Method of Variations in a satisfactory light, without employing instead of equations, the other kind of comparisons here alluded to.

$$\delta u' - \frac{du'}{dx}\delta x - \frac{du'}{dy}\delta y - \frac{du'}{dz}\delta z - \&c.$$
$$= \frac{d}{dx}\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z - \&c.\right);$$

where u' is put for $\frac{du}{dx}$.

Now $\frac{du}{dx}\delta x + \frac{du}{dy}\delta y + \frac{du}{dz}\delta z + \&c.$ is the variation in the function u, that is due to the variations δx, δy, δz, &c. independently of any change in the *form* of that function. And the excess of the whole variation δu above this partial variation, may be regarded as the variation occasioned in the function by its change of form. Let this excess be denoted by Δu, and let a similar notation be used in other like cases. Then $\Delta u' = \frac{d\Delta u}{dx}$; that is, $\Delta\frac{du}{dx} = \frac{d\Delta u}{dx}$. Hence we readily derive the general equation

$$(2.) \qquad \Delta\frac{d^{l+m+n\&c.}u}{dx^l dy^m dz^n \&c.} = \frac{d^{l+m+n\&c.}\Delta u}{dx^l dy^m dz^n \&c.}.$$

Now for brevity, let D be put for the complex characteristic $\frac{d^{l+m+n\&c.}}{dx^l dy^m dz^n \&c.}$; then since ΔDu is only a substitute for the expression $\delta Du - \frac{dDu}{dx}\delta x - \frac{dDu}{dy}\delta y - \frac{dDu}{dz}\delta z - \&c.$ and, as has just been proved, is equal to $D\Delta u$ or $D\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z + \&c.\right)$ it follows that

$$(3.) \qquad \delta Du = D\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z - \&c.\right)$$
$$+ \frac{dDu}{dx}\delta x + \frac{dDu}{dy}\delta y + \frac{dDu}{dz}\delta z + \&c.$$

which is the general formula required: for it exhibits the value of the variation of any differential coefficient of u, due to the assumed variations δu, δx, δy, δz, &c. in terms of those variations; in other words, it assigns for the dependent variation δDu, in which δ is separated from u by the characteristic D, an expression in which none but the assumed variations occur, in which the characteristic δ is found, only as *immediately* preceding one or another of the variables u, x, y, z, &c.

We have now to state a second method of obtaining the same result; the method to be preferred as the most simple and direct. We will begin by showing that when a function varies in con-

sequence of changes in the values of its variables and in its form, the whole variation is equal to the variation due to the change in the form of the function, independently of any change in the variables, added to the variation which is due to the changes in the values of the variables independently of any change in the form of the function: a theorem which though seemingly obvious, is not however to be assumed without proof.

Let $u=F(x, y, z, \&c.)$, and by variation let x, y, z, &c. become x, y, z, &c. while u becomes u+v, where $u=F(x, y, z, \&c.)$ and $v=f(x, y, z, \&c.)$. Then the whole variation of u which we will denote by δu, is $u+v-u$. But if there were the same change as we have supposed in the form of the function, without any variation in x, y, z, &c. the variation of u would be $f(x, y, z, \&c.)$, which we may denote by v or Δu. And if there were no variation in the form of the function u, but the same variation as has been supposed in the values of x, y, z, &c. the variation of u would be $u-u$, which we will denote by Γu. Then $\delta u=\Delta u+\Gamma u+(v-v)$. But as v is the same function of x, y, z, &c. that v is of x, y, z, &c. $(v-v)$ is an infinitesimal of the second order and may be neglected. We have then finally the equation

$$\delta u=\Delta u+\Gamma u; \tag{4.}$$

a result which verifies the theorem stated above. We now proceed to determine the variation of a differential coefficient of a function. Let u be the function, and Du the differential coefficient; where D is put for $\frac{d^{l+m+n}\,\&c.}{dx^l dy^m dz^n\,\&c.}$. Then when u varies to u+v, Du varies to D(u+v), where D is put for $\frac{d^{l+m+n}\,\&c.}{dx^l dy^m dz^n\,\&c.}$. And if δDu be put for the variation of Du,

$$\delta Du=D(u+v)-Du=Du+Dv-Du.$$

But Du is the same function of x, y, z, &c. that Du is of x, y, z, &c.: then agreeably to the notation already used, ΓDu may be put for $Du-Du$. And as Dv is the same function of x, y, z, &c. that Dv is of x, y, z, &c., $Dv=Dv+\Gamma Dv$. Hence if the infinitesimal ΓDv, which is of the second order, be neglected, and if for v, its equivalent Δu be substituted,

$$\delta Du=D\Delta u+\Gamma Du: \tag{5.}$$

and if for Δu we substitute its equal $\delta u-\Gamma u$, then

$$\delta Du=D(\delta u-\Gamma u)+\Gamma Du. \tag{6.}$$

Now the meaning of Γ is such that if infinitesimals of the second order be neglected,

$$\Gamma u=\frac{du}{dx}\delta x+\frac{du}{dy}\delta y+\frac{du}{dz}\delta z+\&c. \tag{7.}$$

Therefore,

$$(8.)\qquad \delta Du = D\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right) + \frac{dDu}{dx}\,\delta x + \frac{dDu}{dy}\,\delta y + \frac{dDu}{dz}\,\delta z + \&c.$$

which is the same as the equation (3) before obtained.

If Du be put for u in the equation (4), then

$$(9.)\qquad \delta Du = \Delta Du + \Gamma Du;$$

and if this be compared with the equation (5), it follows that

$$(10.)\qquad \Delta Du = D\Delta u;$$

which is of the same import with the above equation (2). The equation (8) may be presented in another simple form, that is worthy of notice, when $l+n+m+\&c. = 1$; as for example, when $l=1$, and $0=m=n=\&c.$ for then

$$\delta\frac{du}{dx} = \frac{d}{dx}\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right) + \frac{d^2u}{dxdx}\,\delta x + \frac{d^2u}{dxdy}\,\delta y + \frac{d^2u}{dxdz}\,\delta z + \&c.$$

or

$$(11.)\qquad \delta\frac{du}{dx} = \frac{d\delta u}{dx} - \frac{du}{dx}\frac{d\delta x}{dx} - \frac{du}{dy}\frac{d\delta y}{dx} - \frac{du}{dz}\frac{d\delta z}{dx} - \&c.$$

which is the same as the former equation (1).

Mr. Delaunay, in a paper on the calculus of variations lately published, and which has particular reference to the variations of Multiple Integrals, has thought it sufficient to vary the limits of integration, and the *form* of the function which the dependent variable is of the independent variables, without assigning to the latter any variations; in which case no investigation is needed to determine the variation of a differential coefficient of the dependent variable; for it is obvious at once, that

$$\delta\frac{d^{l+m+n\ \&c.}u}{dx^l dy^m dz^n\ \&c.} = \frac{d^{l+m+n\ \&c.}}{dx^l dy^m dz^n\ \&c.}\delta u.$$

Now with reference to the variation of a double *definite integral*, it is plain that if the integral be presented in the following form, $\int_a^A dx \int_{f(x)}^{F(x)} dy\ \mathrm{V}$, and be considered a substitute for such an expression as this, viz., $\mathrm{W}_{\substack{y=F(A)\\x=A}} - \mathrm{W}_{\substack{y=F(a)\\x=a}} - \mathrm{W}_{\substack{y=f(A)\\x=A}} + \mathrm{W}_{\substack{y=f(a)\\x=a}}$; where W is such a function of x and y, that $\frac{d\mathrm{W}}{dx} + \frac{d\mathrm{W}}{dy}\frac{dy}{dx} = \mathrm{U}$, and U such that $\frac{d\mathrm{U}}{dy} = \mathrm{V}$, then the method of Delaunay will suf-

fice, and the variation of the integral may be exhibited with entire generality in the following manner,

$$\delta\int_a^A dx\int_{f(x)}^{F(x)} dy\ \mathrm{V} = \int_a^A dx\int_{f(x)}^{F(x)} dy\ \delta\mathrm{V} + \int_a^A dx\ \left(\underset{y=F(x)}{\mathrm{V}\delta F(x)} - \underset{y=f(x)}{\mathrm{V}\delta f(x)}\right)$$

$$(12.)\qquad +\delta A\int_{f(A)}^{F(A)} dy\ \mathrm{V}_{x=A} - \delta a\int_{f(a)}^{F(a)} dy\ \mathrm{V}_{x=a};$$

where $\delta\mathrm{V}$ denotes the variation in the form of V considered as a function of x and y. But it may at times be necessary or convenient to regard a double or other multiple *definite integral* as the sum of an infinite number of infinitesimal elements, or more correctly perhaps as the limit of this sum, and variations may need to be attributed to these infinitesimal elements *severally* rather than *in the aggregate*, in which cases, (as has been remarked by Ampère in a paper on the Calculus of Variations applied to mechanics,) it is not sufficient to regard the variations of the independent variables as nothing, but general values must be assumed for them as well as for the variations of the dependent variables. The method of Delaunay is therefore essentially deficient in generality.

By means of the formulæ already stated, it is easy to obtain the proper expression for the variation of any function of both dependent and independent variables. Let V be such a function, whose variation is to be determined; let the independent variables be x, y, z, &c., and let P be one of the dependent variables. Then as V is a function of x, y, z, &c., and of quantities which are functions of x, y, z, &c., it is virtually a function of these independent variables only; and though regarded as a *uniform* function in respect to *all* the variables, dependent and independent, that are contained in it, it may however be considered variable in its form, when viewed as a function of the independent variables, on account of the variations in the forms of the dependent variables.

Then in the general equation $\delta\mathrm{V} = \Delta\mathrm{V} + \Gamma\mathrm{V}$, $\Delta\mathrm{V}$ must be the sum of all the partial variations of V, that are analogous to the following, $\dfrac{d\mathrm{V}}{d\mathrm{P}}\Delta\mathrm{P}$; which sum may be denoted thus $\Sigma\dfrac{d\mathrm{V}}{d\mathrm{P}}\Delta\mathrm{P}$. But P may be a differential coefficient of a function: we will suppose it such, and put instead of it, Du, that is, $\dfrac{d^{l+m+n\ \&c.}\,u}{dx^l dy^m dz^n\ \&c.}$. Then,

$$\Delta\mathrm{V} = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}\,\Delta Du = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}\,D\Delta u = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}\,D(\delta u - \Gamma u).$$

Therefore,

$$\delta V = \Sigma \frac{dV}{dP}\, D\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right) + \frac{dV}{dx}\,\delta x + \frac{dV}{dy}\,\delta y + \frac{dV}{dz}\,\delta z + \&c., \tag{13.}$$

where $P = Du$, and $\frac{dV}{dx}$, $\frac{dV}{dy}$, $\frac{dV}{dz}$, &c., are *complete* or *total* differential coefficients with respect to x, y, z, &c.

One other theorem, which has not, we believe, been elsewhere stated, seems worthy of notice here.

Let V be a function of several variables, x, y, z, &c., either variable or constant in its form with respect to them; then by virtue of the equation (1), we readily obtain the following,

$$dx\,\delta\frac{dV}{dx} + dy\,\delta\frac{dV}{dy} + dz\,\delta\frac{dV}{dz} + \&c. = d\delta V - \frac{dV}{dx}\,d\delta x - \frac{dV}{dy}\,d\delta y - \frac{dV}{dz}\,d\delta z - \&c. \tag{14.}$$

Now regarding dV as a *uniform* function of $\frac{dV}{dx}$, $\frac{dV}{dy}$, $\frac{dV}{dz}$, &c. dx, dy, dz, &c., viz., the function $\frac{dV}{dx}dx + \frac{dV}{dy}dy + \frac{dV}{dz}dz + \&c.$, we have the equation,

$$\delta dV = dx\,\delta\frac{dV}{dx} + dy\,\delta\frac{dV}{dy} + dz\,\delta\frac{dV}{dz} + \&c. + \frac{dV}{dx}\delta dx + \frac{dV}{dy}\delta dy + \frac{dV}{dz}\delta dz + \&c., \tag{15.}$$

which combined with the last gives the following,

$$\delta dV = d\delta V + \frac{dV}{dx}(\delta dx - d\delta x) + \frac{dV}{dy}(\delta dy - d\delta y) + \frac{dV}{dz}(\delta dz - d\delta z) + \&c.$$

and if we put the characteristic θ for $(\delta d - d\delta)$,

$$\theta V = \frac{dV}{dx}\theta x + \frac{dV}{dy}\theta y + \frac{dV}{dz}\theta z + \&c. \tag{16.}$$

which is the theorem that was to be stated.

If either of the variables x, y, z, &c., as for example x, is a function of the rest, whether variable in its form or not, then

$$\theta x = \frac{dx}{dy}\theta y + \frac{dx}{dz}\theta z + \&c.,$$

and

$$\theta V = \left(\frac{dV}{dx}\frac{dx}{dy} + \frac{dV}{dy}\right)\theta y + \left(\frac{dV}{dx}\frac{dx}{dz} + \frac{dV}{dz}\right)\theta z + \&c.;$$ or if $\frac{dV}{dy}$, $\frac{dV}{dz}$, &c.

be put for *total* differential coefficients of V, with respect to y, z, &c., $\theta V = \frac{dV}{dy}\theta y + \frac{dV}{dz}\theta z$, &c.; the same result that would be obtained by regarding V at first as a function of only y, z, &c., subject to all the variation of form with respect to these variables, which is due to any variation of form that may have been attributed to it, with respect to x, y, z, &c., and which is due to any variation of form that may be assumed for x, considered as a function of y, z, &c.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the presence of Fluorine in Anthracite;* by George C. Schaeffer, (communicated for this Journal.)—But little attention has hitherto been paid to the curious pseudo-sublimate formed in the flues of stoves in which anthracite coal is burned. Several years ago a committee of the Franklin Institute made a report on the corrosion of iron pipe, &c. by the burning of anthracite. This is the only notice of this substance known to us. The committee attributed the corrosion to the action of ammoniacal salts containing sulphuric acid and chlorine.

The substance in question is not wholly a sublimate, being formed partly by the condensation of ammoniacal salts and partly by the direct action of the gaseous products of combustion on the iron; when the fire has been frequently rekindled, there is more or less mixture of carbonaceous matter.

The action of damp air on this substance when cold, increases the corrosion of the pipe, as demonstrated in the report above mentioned. This however is not the *sole* cause, for large flakes may easily be separated from pipes which have not been exposed to damp air, and these will always be found to contain much iron.

There is another substance found in the pipes; this is formed of the ashes carried up by the draught, and is more or less incrusted and mixed with the condensed products of combustion.

Soon after the report of the committee of the Franklin Institute was published, my attention was drawn to the same subject. I found on subliming even the smallest portion of these flakes in an open glass tube, that the glass was corroded. As I was engaged in determining the presence of another substance, I did not pay much attention to this indication of the presence of fluorine.

I have more recently tried the usual test for fluorine, and find that with a small quantity of the sublimate, the glass is always engraved; even a few grains will suffice to give marks which are visible when the glass is dimmed by breathing on it.* This reaction uniformly takes

* If the leaden vessel in which this experiment has been tried, is allowed to stand for some time, a large quantity of transparent and perfect octahedrons of iron and ammonia alum will be found. These may be readily freed from the black residue by agitation with a small quantity of water. The crystals however soon become opake and brown when exposed.

place, and we may therefore add fluorine to the number of elements already found in anthracite.

Since making these experiments, my attention has been directed to a note by the Messrs. Rogers, on the occurrence of fluor spar in anthracite; these gentlemen correctly attribute the fluorine to the vegetation of the coal plants, although no attempt seems to have been made to determine its constant presence in the coal.

A single trial has shown that phosphoric acid is likewise present. I have not repeated the experiment, but there can be no doubt that this constituent of plants of our era, was equally abundant in the coal plants.

It may be remarked, that the sulphur is not altogether found as sulphuric acid in the sublimate, for hydrochloric acid disengages a large quantity of sulphurous acid. The investigation of this curious substance is not yet completed. The results, if worth recording, will be communicated to this Journal.

2. *Arseniate of Magnesia and Ammonia, and its applications;* by M. Levol, (Com. Rend., July, 1846; Ann. de Chim. et de Phys., Aug., 1846.)—This salt is said to correspond in all respects with the phosphate of magnesia and ammonia; it is formed in the same way and possesses the same sparing solubility in water containing ammonia. The presence of one part of arsenic acid in 56818 of ammoniacal water was rendered evident on the addition of a strong solution of ammoniacal sulphate of magnesia. M. Levol proposes this salt as a means of estimating arsenic acid when arsenious acid is present. The dried precipitate must be heated to a red heat, care being taken to avoid reduction of the acid, there remains $2MgO, AsO_5$. The insolubility of this salt renders it probable that the ammoniaco-magnesian salts will prove antidotes in cases of poisoning with arsenic acid. G. C. S.

3. *On the Acids of Tobacco;* by M. E. Goupil, (Com. Rend., July, 1846;-Ann. de Chim. et de Phys., Aug., 1846.)—The chief organic acid of the tobacco is the malic. Bimalate of ammonia may be obtained readily from the plant, which in its dry state affords 3 to 4 per cent. M. Goupil has discovered that the conversion of the precipitated malate of lead into a crystalline mass does not take place unless there is free acid present. This is an important fact, as the conversion into crystals is commonly assigned as a distinguishing character.

Citric acid is found in the tobacco plant but in a very small quantity. No other organic acids could be found. G. C. S.

4. *On the Fusion of Phosphorus;* by M. Ed. Desains, (Comptes Rendus, July, 1846.)—The melting point of phosphorus, determined very carefully, was found to be 111½°. The phosphorus should be covered with water and constantly agitated while cooling; without this precaution it may remain liquid even at 72°; on solidifying, its temperature rises to about 104°. The rate of cooling of the solid and liquid phosphorus between these two points would indicate the same specific heat for the two different states of the substance.

5. *On Coffee*, (third part;) by M. Payen.—In order to isolate the aromatic substance of the coffee, the usual hot infusion was distilled in a vessel connected with several successive receivers kept at different temperatures. The aromatic principle was found almost entirely condensed in that which had preserved a temperature of about 80°. Sev-

eral purifications are required to separate a solid fat which is entirely inodorous; the true aromatic substance is a mixture of two oils, one probably an alteration of the other. This oil, upon which the flavor of the coffee depends, is but the ·0002 of the berry; it is not surprising, therefore, that a single drop diffuses the odor of coffee throughout a room.

M. Payen gives a curious calculation of the value of this aroma, by which it appears that about one thousand dollars per pound is paid for this oil. G. C. S.

6. *Determination of Nitrogen in Organic Bodies;* by GEORGE KEMP, M. D., (Chem. Gaz., Nov., 1846.)—Dr. Kemp cautions us against the following source of error in the manipulation of Varrentrap and Will's process for estimating nitrogen. When the substance to be analyzed contains a small proportion of nitrogen and much hydrogen, a larger quantity of the substance must be taken to obtain a sufficient amount of ammonia. Much water is of course formed, and this condensing in the cooler parts of the tube, forms a pasty mass with the soda-lime, which forms a plug in the front end of the tube, and spoils the analysis, or at the drawn-out end prevents the removal of all the ammonia, so that as much as one-third may be lost. To avoid this difficulty, four parts of lime to one of hydrate of soda are to be used, instead of the usual proportion of two to one. The end, instead of being drawn up abruptly, is to be drawn out for about a quarter of an inch, and then upwards, so as to form a segment of a circle. In loading the tube, about an inch of coarsely powdered lime is to be introduced before the mixture.

Dr. Kemp also points out the ammonia floating in the air, as a source of error, particularly in large laboratories, where several different operations are carried on at the same time, and by different persons; in private laboratories, there is less risk of introducing ammonia in this way. G. C. S.

7. *On the Preparation of Caustic Baryta;* by Dr. E. RIEGEL, (Chem. Gaz., Nov., 1846.)—The author gives the preference to the process with sulphuret of barium and peroxyd of manganese, as described in the books; with oxyd of copper, he states that the product is less pure, as the ley generally contains a slight trace of copper. This is directly contrary to what is commonly asserted of these two methods. G. C. S.

8. *Nitrogen not a Constituent of Picrotoxine;* ERDMANN and MARCHAND, (quoted in Jour. de Pharm. et de Chim., ix, p. 470.)—Liebig has asserted, when speaking of the vegetable alkalies, that "no remedy, devoid of nitrogen, possesses a poisonous action in a similar dose;" and adds that this consideration led to the re-examination of picrotoxine, by Mr. Francis, who ascertained that nitrogen did exist in it.

This being contrary to the analysis of several distinguished chemists, Messrs. Erdmann and Marchand have examined the subject with the greatest care. The test of M. Lassaigne, which, as is well known, is exceedingly delicate, failed to give any indication of the presence of nitrogen. The ordinary mode of combustion was then tried, one gramme of the substance being burned each time. Had the picrotoxine contained half of one per cent. of nitrogen, there would have been collected 4 cub. cent. of that gas. In two experiments, they obtained

·5 and ·7 of a cub. cent., in two others, 4 and 5 cub. cent.; this gas, however, was not nitrogen, *for it was inflammable.* This result shows that caution should be exercised in the determination of nitrogen, and that both carbon and hydrogen may escape combustion and create a loss, falling of course mainly upon the carbon. G. C. S.

9. *On the Influence of Protoxyd of Nitrogen upon Vegetation;* by M. Vogel, Jr., (Jour. de Pharm. et de Chim., x, p. 101.)—Seeds of the cress were exposed on a moistened sponge to an atmosphere of pure protoxyd of nitrogen. For the sake of comparison, seeds were placed in the same manner in a jar of common air. At the end of a few days, the latter vegetated and began to form leaves. The seeds in the protoxyd swelled, and were covered with a mucous coat, but remained for two weeks without any other signs of vegetation. On being taken out and exposed to the air, they immediately germinated. The gas was found unaltered.

Plants of the cress were then introduced into the gas; on the third day they became yellow, and at the end of a week they drooped. Brought into the air, they resumed in a few days their green color and erect position.

From these experiments, the author concludes that the protoxyd of nitrogen favors neither the germination of seeds, nor the vegetation of plants already forward, that the gas is not decomposed by the leaves, even under the direct rays of the sun, and that seeds do not lose their vitality by a short exposure to its influence.

These conclusions are true for the pure gas, but it by no means is to be inferred that the gas is altogether unfavorable to vegetation; we are persuaded that the contrary will be found true. In a similar manner, Braconnot, not long since, demonstrated that salt was injurious to vegetation: plants coated with a tolerably strong solution of salt, withered and died; *ergo*, salt was injurious! G. C. S.

10. *On the Volatile Oils of the Cruciferæ;* by F. Pless, (Liebig's Annalen, lviii, p. 36.)—The leaves and seeds of the *Thlaspi arvense* yield, by distillation with water, a volatile oil, which, on examination, proves to be a mixture of oil of mustard and oil of garlic. This oil does not preëxist in the plant.

The leaves and seeds of *Alliaria officinalis* give a similar mixture of these two oils, although the oil of garlic is sometimes absent.

The oil of mustard alone is formed from the leaves of *Iberis amara*, and in very small quantity from the seeds of *Capsella bursa-pastoris*, (shepherd's purse,) *Raphanus raphanistrum*, (charlock,) and *Sisymbrium officinale*, (hedge mustard.)

An essential oil, containing sulphur, is also obtained by macerating in water the seeds of *Lepidium ruderale*, *L. sativum*, (pepper-grass,) and *L. campestre*.

The same reaction is observed with the roots and seeds of the radish, and the seeds of the *Brassica napus*, *Cochlearia draba* and *Cheiranthus annuus*, (stock jilly.) G. C. S.

11. *On the Oil of Monarda;* by A. E. Arppe, (Liebig's Annalen, lviii, p. 41.)—This oil, the product of the *Monarda punctata*, (horsemint,) was brought from the United States. It consists of a fluid oil and a stearoptene. The former is a yellowish-red fluid, with the odor of

thyme; it boils at 435° F. It is apparently a mixture, as the stearoptene boils nearly at the same point. It is easily converted into a resin by contact with the air or any drying substances.

The stearoptene forms fine crystals; its boiling point is 428°. The formula is C_{10} H_7 O. (Gerhardt remarks that this is the formula for stearoptene of carraway oil.) This substance combines with hydrochloric acid gas, but does not form a crystalline compound. G. C. S.

12. *On the Substances contained in Achillea millefolium*, (*Yarrow;*) by B. Zanon, (Liebig's Annalen, lviii, p. 21.)—This plant possesses much reputation as a febrifuge, both in this country and in Europe. M. Zanon obtained from it a bitter extract, which he calls *Achilleine*, and a crystallized non-volatile acid, which formed salts with potash, soda, ammonia, lime and quinine. No analysis is given, so that we are unable to say whether the *achilleic* acid and the extract are new substances, or are already known. G. C. S.

13. *On the Formation of Caoutchouc from Drying Oils;* by L. E. Jonas, (Archiv. de Pharm., xlvi, p. 159.)—Linseed oil, boiled for a long time, yields a brownish varnish; this is to be boiled for a long time in water containing nitric acid, the loss by evaporation must be supplied and the acid not allowed to act too violently. At last a substance is obtained, which gradually solidifies; this is to be washed to free it from acid. This substance does not adhere to the fingers, is plastic, does not melt by itself, and when heated, strikingly resembles caoutchouc.

It dissolves partially in ether and sulphuret of carbon; entirely in oil of turpentine. Walnut and poppy oils furnish the same body, to which the name of oil-caoutchouc is given.

When linseed oil is boiled with half a part of sulphur, as soon as the temperature reaches a certain point, the whole is converted into a gelatinous mass, resembling oil-caoutchouc; dilute nitric acid converts all the sulphur into sulphuric acid; the residue has a brick-red color, which however is not elastic. G. C. S.

14. *Purification of Mercury;* by M. Millon, (Ann. de Chim. et de Phys., Nov. 1846.)—Mercury may be perfectly purified by agitating it for a considerable time with weak nitric acid. With two pounds of the metal, about an ounce and a half of the acid diluted with twice its volume of water may be employed. The mercury freed from the nitrate thus formed is to be boiled with pure nitric acid sufficient to dissolve about nine-tenths of the metal; the resulting nitrate of mercury is to be reduced to red oxyd by heat, and this is to be calcined in a porcelain retort to reduce it.

By the action of the first portion of nitric acid the more oxydable metals are acted upon; the second portion of acid leaves the metals less oxydable than mercury in the undissolved portion.

As the mercury reduced by this process dissolves a notable quantity of oxyd, this last is to be separated by agitation with sulphuric acid; it is afterwards to be washed with a very large quantity of water, and dried in the receiver of the air-pump over sulphuric acid. Mercury thus purified was employed by M. Regnault in his third determination of its density.

M. Millon states that when a saline solution, such as chlorid of calcium, hydrochlorate of ammonia, nitrate of potash, &c., is added to

mercury in a bottle, the mercury is always divided into rounded globules, which remain separated from each other for a long time; but what is very striking is, that the size of the globules, which varies enormously, is always connected with the nature of the aqueous solution. Some solutions immediately cause extreme division in the mercury; others, on the contrary, produce only very large globules, to whatever extent the agitation may have been carried; and the same effect is always produced with the same solution. It is to this influence of saline solutions that is due the difficulty often witnessed in collecting mercury when it has been reduced in the moist way.

15. *Grove's Galvanic Battery, improved for the use of the Telegraph.*—To increase the power of this battery, it is common to amalgamate the zinc cylinders with mercury. In the use of the battery at the stations of the telegraph, the mercury is soon attacked by the nitric acid which passes through the porous cup or by impurities in the sulphuric acid, and perhaps by both. It thus became necessary to repeat the amalgamation daily or every day or two, at no inconsiderable expense from the oxydation of the mercury. In trying some experiments, Mr. Swan of this city, was led to put crystals of sulphate of soda into the diluted sulphuric acid, when he found the action to be more uniform, and the mercury to be unattacked. On making the trial of the sulphate of soda in the telegraph battery, the experiment was entirely successful and the amalgamation was not repeated for weeks. In the new line on the Canada shore, it is stated by the superintendent, that they began with the use of the sulphate of soda, and that the quicksilver appeared uninjured after weeks of use. Should this fact be established, the saving on the telegraph lines will be some thousands of dollars annually. Indeed the experiments are already conclusive. The result is probably due to the decomposition of the sulphate of soda, by which nitrate of soda is formed and sulphuric acid liberated, while the nitric acid is thus prevented from acting on the quicksilver. There may be other effects; but the advantage gained from the sulphate of soda is very great. The crystals of sulphate of soda must be renewed so often that the dilute sulphuric acid may be a saturated solution. C. D.

Rochester, Feb. 15, 1847.

16. *Maximum Density of Pure Water*, (Phil. Mag., Jan., 1847, xxx, 41.)—Messrs. Joule and Playfair, after detailing several series of experiments, give as their final conclusion, which they remark cannot be more than a hundredth of a degree from the truth, that the maximum density of pure water is 39°·1 F. They object to the use of 60° F. as a standard in researches on specific gravity, on account of the high rate of expansion of water at that temperature, and suggest, that there would be greater accuracy if water at its maximum density were taken as the unit. This standard has already been adopted in France under the authority of Arago.*

The result arrived at by Despretz, from a very extensive series of experiments with an apparatus similar to that employed by Hope, was

* This standard was used by Mr. Hassler, in his elaborate investigations during the years 1830–1832, with regard to the weights and measures of the United States, after previously determining, by a long series of experiment, 39°·83 to be the temperature of maximum density.

39°·176, which agrees nearly with the above result. But other results show considerable discrepancy; e. g., Hallström, 39°·38, Blagden and Gilpin, 39°, Hope, 39°·5, Deluc, 41°, Lefebvre Gineau, 40°, Dalton, 38°, Rumford, 38°·8, Muncke, 38°·804, Stampfer, 38°·75 F. The mean of all these observations, is 39°·24.

17. *On a new and practical form of Voltaic Battery of the highest powers, in which Potassium forms the positive element;* by JOHN GOODMAN, Esq. Communicated by S. Hunter Christie, Esq.. A.M., Sec. R.S., (Royal Soc., Jan. 11; Phil. Mag., Feb., 1847, xxx, 127.)—The author succeeded in constructing a voltaic arrangement of some power by fixing a piece of potassium to the end of a copper wire, placed in a tube containing naphtha, and bringing it into contact with a small quantity of mercury, held by a layer of bladder closing the lower end of the tube, which was itself immersed in acidulated water immediately over a piece of platinum, and then completing the circuit by establishing a metallic contact between the copper wire and the platinum. This battery acted with energy on the galvanometer, and effected the decomposition of water. A series of twelve pairs of similar plates exhibited a sensible attraction of a slip of gold leaf. Thus it appears that the substance which possesses the highest chemical affinity manifests also the greatest power of electrical tension.

18. *On Photographic Self-Registering Meteorological and Magnetical Instruments;* by FRANCIS RONALDS, Esq., F.R.S., &c., (Royal Soc., Jan. 21; Phil. Mag., Feb., 1847, xxx, 127.)—The apparatus employed by the author at the Kew Observatory, and which he terms the Photo-Electrograph, is described by him in the following words:—"A rectangular box, about sixteen inches long and three square, constitutes the part usually called the *body* of a kind of lucernal microscope. A voltaic electrometer (properly insulated, and in communication with an atmospheric conductor) is suspended within the microscope, through an aperture in the upper side, and near to the *object end*. That end itself is closed by a plane of glass, when daylight is used, and by condensing lenses, when a common Argand lamp is employed. In either case an abundance of light is thrown into the microscope. Between the electrometer and the ether, or eye-end of the microscope, fine achromatic lenses are placed, which have the double effect of condensing the light upon a little screen, situated at that eye-end, and of projecting a strong image of the electrometer, in deep *oscuro*, upon it. Through the screen a very narrow slit, of proper curvature, is cut, (the chord of the arc being in a horizontal position,) and it is fitted into the back of a case, about two-and-a-half feet long, which case is fixed to the eye-end of the microscope, at right angles with its axis, and vertically. Within the case is suspended a frame, provided with a rabbet, into which two plates of pure thin glass can be dropped, and brought into close contact by means of six little bolts and nuts. This frame can be removed at pleasure from a line, by which it is suspended, and the line, after passing through a small aperture (stopped with grease) cut through the upper end of the long case, is attached to a pulley (about four inches in diameter) fixed, with capacity of adjustment, on the hour arbor of a good clock. Lastly, counterpoises, rollers, springs, and a straight ruler are employed for ensuring accurate rectilineal sliding of the frame, when the clock is set in motion.

"A piece of properly prepared photographic paper is now placed between the two plates of glass in the movable frame; the frame is removed (in a box made purposely for excluding light) and is suspended in the long case; this is closed, so as to prevent the possibility of extraneous light entering with it; the clock is started, and the time of starting is noted.

"All that part of the paper which is made to pass over the slit in the screen, by the motion of the clock, becomes now therefore successively exposed to a strong light, and is consequently brought into a state which fits it to receive a dark color on being again washed with the usual solution, excepting those small portions upon which dark images of the lower parts of the pendulums of the electrometer are projected through the slit. These small portions of course retain the light color of the paper; and form the long curved lines or bands, whose distances from each other, at any given part of the photograph, i. e. at any given time, indicate the electric tension of the atmosphere at that time.

"By certain additions to the instrument above described, the kind as well as the tension of electrical charge is capable of being registered; and by the employment also of a horizontal thermometer, &c., it is adapted to the purposes of a *Thermograph*, as well as *Photo-barometrograph* and *Magnetograph*."

II. Mineralogy and Geology.

1. *Buratite, a new Mineral;* by M. Delesse, (Comptes Rendus, Oct. 26.)—This mineral is a hydrous carbonate of zinc, copper and lime, in definite proportions; it crystallizes in bluish radiating needles; and has the specific gravity 3·20. According to the analysis of M. Delesse, it consists of carbonic acid 21·45, oxyd of zinc 32·02, lime 8·62, oxyd of copper 29·46, water 8·45. This leads to the formula $2(Zn, Cu, Ca,)\,C+aq$, or admitting the ideas of M. Scheerer on polymerous isomorphism, $CO^2\,(RO)^2$.

Buratite has been found in the copper mines of Lotefskoi in the Altai mountains, at Chessy near Lyons, at Temperino in Tuscany, and at several other localities.

2. *Groppite, a new Mineral;* by L. Svanberg, (Arsb. Berz., 1846, p. 240.)—This mineral, from Gropptorps, constitutes a rose red to brownish red crystalline mass having much resemblance to rosite. The structure is somewhat foliated. Hardness between that of gypsum and calc spar; specific gravity 2·73. It affords water before the blowpipe, and on analysis gave, silica 45·008, alumina 22·548, oxyd of iron 3·063, lime 4·548, magnesia 12·283, potash 5·227, soda 0·215, water 7·110, undecomposed 0·131 = 100·213, leading to the formula $rS^2+2AS+Aq$. It is near gigantolite in composition.

3. *Herschelite*, (Ann. de Ch. et de Phys., xiv, 97.)—According to Damour, Herschelite is a zeolite with essentially the same composition as chabazite, or $\dot{R}^3\ddot{S}i^2+3\ddot{A}l\ddot{S}i^2+15\dot{H}$. The analysis agrees very closely with Thomson's analysis of the variety Levyne.

4. *Aspasiolite, a new Mineral;* by M. Scheerer, (Arsb. Berz., 1846, p. 241.)—Aspasiolite occurs with iolite, quartz, feldspar and mica at Kragerö, in Norway. It resembles iolite in crystalline form, has a greenish color, the hardness of calc spar, and the specific gravity

2·764. In composition it differs little from iolite, affording silica 50·90, alumina 32·38, magnesia 8·01, lime *a trace*, protoxyd of iron 2·34, water 6·73, manganese *a trace*.

5. *Castor and Pollux, two new minerals;* by BREITHAUPT and PLATTNER, (Pogg. Annal., lxix.)—These minerals occur in granite on the Island of Elba. *Castor* has a vitreous lustre and rough surface, and is transparent and colorless, with two axes of double refraction and two cleavages inclined at an angle of 128½ or 129 degrees. Hardness, a little above adularia; specific gravity 2·3801—2·401. Fuses with difficulty before the blowpipe to a limpid colorless glass, coloring the exterior flame red. Composition according to Plattner, silica 78·012, alumina 18·856, peroxyd of iron with traces of manganese 1·613, lithia with traces of potash and soda 2·760=100·241.

Pollux resembles castor in crystallographic and physical characters, except that there are only traces of cleavage, and it has the specific gravity 2·868 to 2·892. Heated in a tube, water is disengaged. Before the blowpipe the edges are rounded to a blebby enamel, and it colors the exterior flame reddish yellow. It contains 46·2 per cent. of silica, with 16·5 of potash, 10·47 of soda and 2·321 of water. There was a loss in the analysis unaccounted for of 7·25 per cent.

6. *Pleochroism.*—Haidinger has applied the term pleochroism to the property pertaining to many crystals, of presenting different colors in different directions. The terms dichroism and trichroism heretofore used are too limited in signification, as different colors are presented in some species in more directions than three.

7. *Russian Geology*, (Proceedings of the Acad. Sci. of St. Petersburg; L'Institut, No. 681, Jan. 20, 1847.)—M. HELMERSEN has ready for publication an extended account of the geological observations which he has made in his different journeys through the departments of Livonia, Estonia, Pskov, St. Petersburg, Novgorod, Tver, Moscow, Toula, Kalouga and Orel; and in the summer of 1845, he made a tour into Sweden and Norway in order to compare his results with the facts there presented and give greater completeness to his description of the palæozoic and other deposits of Northern Europe.

8. *On Slaty Cleavage in North Wales;* by DANIEL SHARPE, (Geol. Soc., March, 1844; Quart. Journal Geol. Soc., No. 7, p. 309.)—In the course of a valuable article on the geology of North Wales, Mr. Sharpe makes the following statements with regard to slaty cleavages.

In North Wales, not only in the Cambrian but also in the Lower Silurian rocks, slaty cleavage is universal: it is very common in the Wenlock series; and in many localities it runs, in a marked degree, through the whole thickness of the Ludlow shales; but in other localities these shales are wholly exempt from it. The principal epoch of slaty cleavage, however, preceded the formation of the Ludlow beds; for these beds are in many instances undisturbed by the faults which have broken up the planes of cleavage in the older rocks. The author was assiduous in measuring the position of the planes of bedding and cleavage in various parts of North Wales, in the hope of making out some general laws respecting cleavage. In measuring the angles, however, he does not pretend to have approximated nearer than within 5° of the truth, as the surface of the beds is rarely flat enough to allow of greater accuracy.

One law respecting slaty cleavage was announced in 1831 by Professor Sedgwick,* and is now well known: that law is, that the cleavage planes maintain their parallelism over extensive areas, irrespective of the varying position of the beds which they cut through, or of the mineral character of the beds. Another law respecting slaty cleavage was detected by the author† in the progress of his tour, and is the following: viz. that the strike of the cleavage coincides with the strike of the bedding, whenever the latter continues uninterruptedly the same for a considerable distance; but when the strike of the beds is inconstant, and shifts at short intervals, then the cleavage planes hold their course right on, irrespective of the varying position of the planes of bedding; in other words, that the strike of the cleavage coincides with the prevailing strike of the beds in each district, and does not vary with the subordinate and local irregularities in the strike of the beds. Whence it follows, that the strike of the cleavage in a district is far more constant and regular than the strike of the beds.

In order to present, in a succinct form, the evidence from which the author has deduced this second law respecting slaty cleavage, the observations he made, in various parts of North Wales, of the positions of the planes of bedding and cleavage, are arranged in a table. [See Quart. Jour. Geol., p. 315.]

From the author's observations it appears that the district of North Wales in which the parallelism between the strike of the bedding and cleavage appears in the most marked degree, is all that part of Carnarvonshire which lies north of Tremadoc. Throughout this area, on the south of the Holyhead road, the beds as well as the cleavage plains strike northeast. On the west side of the Snowdon anticlinal, the beds are much tossed about and dip at various angles either northwest or southeast, and the cleavage planes are nearly vertical. On the east side of the anticlinal, the beds dip southeast, and the cleavage dips northwest from 60° to 65°. On the eastern side of the Carnarvonshire synclinal, the beds dip northwest, as does also the cleavage, but at an angle which gradually diminishes as you recede from the Snowdon chain. Thus at the Rhiw Brefder quarries the angle is 55°; at the Diffwys quarries it is 45°, and at Manodmawr 35°. Towards the northern extremity of the county of Carnarvon the strike of the beds changes from northeast to N.N.E., as does also the strike of the cleavage. To the south of Tremadoc the beds change in strike from northeast to east, and the cleavage changes in strike from northeast to E.S.E.

The parallelism in the strike of the planes of bedding and cleavage prevails also, in a marked degree, in the slaty district north of the Dee, and also in the North Berwyns. The common strike of the two planes approaches to east; but it is subject to many local variations; and in

* Geol. Trans., ii Ser., vol. iii., p. 68.

† While the author was drawing this conclusion from his observations in Wales, a nearly similar law was announced to the British Association at Cork by Professor Phillips, in the following terms:—"The cleavage planes of the slate rocks of North Wales are always parallel to the main direction of the great anticlinal axis, but are not affected by the small undulations or contortions of these lines. In North Wales they maintain the same direction for fifty miles, not varying more than two or three degrees." [See also, pages 389, 393, 394, of this number.—J. D. D.]

such cases the two planes vary in strike together. The cleavage has a northerly dip at angles varying from 25° to 65°.

In the Barmouth chain the strike of the cleavage is somewhat irregular; but its mean direction is north and south, and its dip is from east 60° to west 60°.

In the district intersected by the great porphyritic eruption of Arenig, Arran Mowddy, &c., the planes of cleavage have lost their original bearings, and are subject to the greatest irregularity both in respect to direction and dip; and the same observation applies to the district of Lower Silurian rocks extending along the Holyhead road between Bryn-y-ddinas and Corwen.

From the circumstance that the position of the planes of cleavage depends, not on the varying position of the beds at each particular spot, but on their main position, the author infers that slaty cleavage cannot have arisen from any power analogous to that of crystallization; and from the almost mathematical regularity with which those planes are arranged, he concludes that they are not the effect of mechanical force or pressure exerted at the moving or upheaving of the rocks.

The author further concludes from his observations, that in those parts of North Wales where the strata are least disturbed, the planes of bedding and cleavage meet at an angle of from 15° to 30°; and hence he infers, that in those cases where, at the time of cleavage, the beds were horizontal, such was also the angle at which the cleavage intersected the bedding (15° to 30°). The author further observed, that in the quarries of North Wales which afford the slate of the best quality, the bedding and cleavage rarely meet at an angle less than 25°, and never less than 20°; and that whenever the angle is less than 20°, the slate is of inferior quality. An increase in the angle at which the planes meet has no injurious effect; for in many instances when the slate is of the best quality, the angle of intersection is 45° and upwards.

9. *On the Salt and Salt Lakes of Algeria;* by H. Fournel, (Ann. des Mines, 1846, ix, 541.)—The extended memoir of M. Fournel gives many interesting details and important deductions with regard to the salt deposits of Algeria. Salt lakes or marshes and streams appear to be innumerable; and besides these, banks and even mountains of salt are met with. The salt is associated with gypsum. The most important deposit is that of the salt mountain near Biskra, where the salt is imbedded in the cretaceous formation. The mines five leagues west of Milah are represented as inexhaustible. The lake Zagrez, which is at least twelve leagues long and two broad, was covered throughout, in April, 1844, with a crust of salt having a glistening surface and looking like ice. The crust which is quite thin in some seasons increases to a foot and finally to more than two feet, towards the middle of the lake. The salt is perfectly white and pure, and of good quality, and the quantity not less than 127 millions of cubic meters. There is a mountain of salt near this lake. Lake *el Mèlah*, in the province of Oran, is another of the same kind, but less extensive.

10. *Volcanic Peak of the Island of Fogo, Cape Verds;* by C. Deville, (Bull. Soc. Geol. de France, 1846, 2d ser., iii, 656.)—The

peak of Fogo is 2790 meters in height. It stands in the centre of a basaltic crater, rising 1000 meters above its base. The enclosing walls extend entire half way around so as to form a semi-circular crest. On the broken side there are numerous scoria cones thrown up at the eruptions of 1785 to 1799, when all that flank of the island was covered with lavas.

Mr. Deville gives many particulars with reference to the island, and presented to the Geological Society of France a topographical chart of it.

11. *Notice of an Example of apparent Drift Furrows dependent on Structure;* by C. B. ADAMS, State Geologist of Vermont, &c. &c., (communicated for this Journal.)—The attention of geologists having been lately called to the question, whether the grooves and striæ commonly attributed to drift agency may not be due to *structure*,* it may not be improper, in anticipation of the results of the survey of Vermont, to mention an example in which this is undoubtedly the case. Mr. Macintosh, the author of the article which is alluded to, and which was read before the Geological Society of London, particularly suggests that such may be the origin of the examples in the United States described by President Hitchcock, a suggestion, we will venture to add, which must have occasioned much surprise in those who are familiar with these effects of drift agency in the New England States, unless they also may have met with facts of the same nature with those which are the subject of this brief notice.

Not far from the geographical centre of Vermont, in the town of Randolph, on ascending a hill a mile east of the centre village, may be seen a ledge of argillo-mica slate, in which the planes of lamination do not coincide with those of deposit. The former have a direction of north 35° east (true meridian) and a dip of 30° to the north 55° west. The true strata have a direction of north and south with a dip of 65° west, and although much less conspicuous than the cleavage planes, are distinguished without much difficulty by a slight difference of materials, in consequence of which they weather unequally, so as to form shallow grooves with a well rounded excavation of three to six inches wide and an inch deep. The coincidence of the direction of these grooves with the ordinary cases of drift furrows, and their obliquity to the planes of lamination which are obvious to the passing traveller, who may not without special examination recognize the true stratification of the rock, as well as the well rounded excavation of the grooves, due no doubt to the gradual transition in the characters of the strata, combine to present a case of extraordinary resemblance to genuine drift furrows.

It is proper to add that the examination of several hundred examples of rounded, smoothed, striated and furrowed rocks has brought to light only this case, in which *structural grooves* bear any resemblance to those which have resulted solely from an external mechanical force. The suggestion of Mr. Macintosh is therefore plainly incapable of general or even common application, although cases may occur in

* See this Journal, ii Ser., Vol. i, p. 277; and Sir R. I. Murchison's Geology of Russia and the Ural Mountains, Vol. i, p. 566.

which it is worthy of careful attention. Indeed, President Hitchcock has himself* most scrupulously distinguished the drift furrows from those which are due to structure. Sir R. I. Murchison also remarks that "the greater number of the deviously parallel scratches on the worn surface of the hard crystalline rocks of the north, are, in our opinion, clearly *mechanical*, and cannot be connected with structural condition."

III. Zoology.

1. *On the Range of the Beaver in the United States;* by S. B. Buckley, (communicated for this Journal.)—In DeKay's Zoology of the State of New York, it is erroneously stated that the most southern limit of the beaver within the United States is the northern part of the State of New York. There were beaver living among the mountains of North Carolina in the year 1842, where I saw trees newly cut down by them, and I was informed by my guide that he had seen the beaver. This was in Haywood County, a few miles from Waynesville, on the Big Pigeon River,—a wild, rough region, abounding in grand scenery and rarely visited by man, being little known even to the hunters.

2. *On the situation of the Olfactory Sense in the terrestrial tribe of the Gasteropodous Mollusca;* by Joseph Leidy, M.D., (Proceed. Acad. Nat. Sci. of Philadelphia, Dec., 1846, iii, 136.)—While no observer of the habits of the terrestrial Gasteropoda doubts the existence of the sense of smell in them, but on the contrary, asserts positively that it does exist, the anatomist has not hitherto been able to point out its precise seat.

Swammerdam, in his Biblia Naturæ, speaks decidedly of the existence of this sense in Helix pomatia, but offers no conjecture as to its situation. Blumenbach remarks, under the head of Vermes, "Several animals of this class appear to have the sense of smelling: as many land-snails (Helix pomatia, &c.") and afterwards adds, "But the organ of this sense is hitherto unknown; perhaps it may be the stigma thoracicum." Cuvier, in his Mémoire sur la Limace et le Colimaçon, after remarking on the delicacy of this sense, thinks it probable it may reside "dans la peau toute entière, qui a beaucoup de texture d'une membrane pituitaire."

In investigating the anatomy of this tribe of Gasteropodous Mollusca, I detected an organ which appeared to have been entirely neglected, or has escaped the notice of those who have dissected these animals. It is a depression or cul-de-sac, having its orifice beneath the mouth, between the inferior lip and the anterior extremity of the podal disk, and which in many species of different genera is elongated backwards into a blind duct, more or less deep, occupying a situation just above the podal disk within the visceral cavity. In Bulimus fasciatus it extends backwards as far as the tail, and is several times folded upon itself; in Glandina truncata it extends the length of the podal disk; in the various species of Helix it is found from a superficial depression to a sac the length of the podal disk; in Succinea obliqua it is of considerable length; in Limax and Arion it is a superficial depression; in an unde-

* Final Report on the Geology of Massachusetts, p. 385.

termined species of Vaginula, hereafter to be described, I found it half an inch in length, &c.

It is composed of two laminæ; a delicate lining mucous membrane and an external layer, having a whitish or reddish glandular appearance. A large nerve, on each side, from the subœsophageal ganglia, is distributed to its commencement, besides which it receives numerous smaller branches along its course from the same ganglia. Its arterial supply is derived from the cephalic branch of the aorta.

This organ, from its situation, relative size to the degree of perfection of the olfactory sense, as in the carnivorous Glandina truncata, &c., its structure, and nervous supply, I think, is the olfactory organ.*

3. *Description of a new species of Anser;* by GEORGE N. LAWRENCE, (Annals Lyc. Nat. Hist. N. York, iv, 171; read March 16th, 1846.)—*Anser nigricans*, Black-bellied Goose. *Specific character*:—

A large white patch on the middle of the neck in front, and extending on the sides; belly brownish black; bill higher than broad at the base.

Bill black, legs and toes black tinged with flesh color, iris dark hazel; head black, tinged with brownish rufous adjoining the bill, with a dirty white line under the eye; neck and fore part of the breast black; a large white patch on the centre of the neck intermixed with black, except at the lower part, where it forms a distinct band of pure white, it is nearly two inches in width, rounding on each side of the neck and almost meeting behind; belly brownish black, sides brownish ash margined with white; back dark brown, each feather margined with a lighter shade; rump-feathers black; axillars and lower wing-coverts greyish black; tail black, consisting of sixteen feathers; upper and lower tail-coverts white; wings black, extending half an inch beyond the tail; second primary one line longer than the first; third half an inch shorter; vent white.

Length 22½ inches; alar extent 44; bill a little higher than broad, measures along the ridge $1\frac{3}{16}$ inches; from gape $1\frac{3}{8}$; lower mandible $1\frac{1}{4}$; tarsus $2\frac{1}{4}$; middle toe 2; outer $1\frac{7}{8}$; inner $1\frac{1}{2}$; weight 3 pounds.

I have taken the above description and figure from an adult female procured at Egg Harbor, N. J., in January. Since then two others have been obtained at the same place, one of which I have in my possession. On dissection it proves to be a male. It agrees in markings with the female, but is evidently a younger bird, being somewhat lighter in the color of its plumage. From this I infer they become darker by age. It is a little larger than the female, the bill being also stouter, measuring $\frac{7}{8}$ in. high at the base. When on a shooting excursion some years since, at Egg Harbor, I noticed a bird flying at some distance from us, which our gunner said was a Black Brant. This was the first intimation I had of such a bird. Upon further inquiry of him, he informed me he had seen them occasionally, but they were not common.

* Since writing the above, I have had an opportunity, through the kindness of Mr. Cassin, of examining a specimen of Helix pomatia, from Europe, in which I find the organ in question existing as a funnel-shape depression beneath the mouth, and extending backwards along the podal disk for the distance of three-fourths of an inch. This I consider particularly interesting, as the same species has been minutely dissected and described by Swammerdam, Cuvier, and others, without any reference whatever to this cul-de-sac.

I have learned from Mr. Phillip Brasher, who has passed much time at that place, that speaking to the gunners about them, they said they were well known there by the name of Black Brant, and one of them mentioned that he once saw a flock of five or six together.

From these facts it appears to be known to gunners, but has heretofore escaped the notice of ornithologists. With all my inquiries I have not been able to procure a specimen before this winter. I think it a good and well-marked species.

4. *A new species of Procellaria from Florida;* by G. N. Lawrence, (Lyc. Nat. Hist., N. Y., Feb. 8, 1847.)—*Procellaria brevirostris.* Above brownish black; beneath white. Bill short; upper tail coverts white; lower, white tipt with ash, and very long: tarsi pale yellow, marked with black at their ends for two-thirds their length. Length 16 inches; extent 39 inches.

5. *Food of the Mastodon;* by Prof. A. Gray, (Proc. Bost. Soc. Nat. Hist., Nov. 1846, p. 92.)—Prof. Gray stated that there had been recently placed in his hands specimens of earthy matter, filled with finely broken fragments of branches of trees, which were said to have been found occupying the place of the stomach in the skeleton of the Mastodon exhumed on Schooley's Mountain, N. J., and lately exhibited in Boston. As similar observations are said to have been made in several instances, Prof. Gray was induced to examine the substance brought to him. The wood evidently consisted of branchlets of one, two and three years old, broken, quite uniformly, into bits of half an inch or so in length, with only, now and then, traces of the bark remaining on the wood. The wood was not at all fossilized, and was but slightly decayed. From the appearance of the branchlets examined, Prof. Gray inferred that they belonged to some coniferous tree or shrub, and, probably, to a kind of spruce or fir, rather than to a true pine. This inference was borne out by the examination of thin slices of the wood by the microscope. The woody fibre was very beautifully and distinctly marked with the circular discs that are characteristic of all coniferous wood. The structure agreed quite perfectly with that in similar branchlets of the common hemlock spruce.

6. *On the Moose and Carabou, and on the American Raven;* by L. Agassiz, (Proc. Bost. Soc. Nat. Hist, Nov. 1846, p. 187.)—These species differ from the European species, according to Prof. Agassiz, who consequently has named them anew, designating the Moose (Cervus alces) the *C. lobatus;* the Carabou, (C. tarandus,) the *C. hastalis;* the American Raven, *C. lugubris.*

7. *Pyranga roseo-gularis, a new species from Yucatan;* by Dr. Cabot, (Proc. Bost. Soc. Nat. Hist., Dec. 2, 1846, p. 187.)—Male, top of head, outer edge of primaries and secondaries, and surface of greater and lesser wing coverts, the tail and its upper coverts, bright brownish-red. Under side of tail and its under coverts, throat and flexures of wings, bright rose-color. Back and posterior part of cheeks dark brownish ash-color; anterior part of cheeks, breast, and belly, bright ash-colored. Twelve tail feathers. Bill strongly toothed, horn-color at top, lighter beneath. Legs and feet horn-colored. Total length $6\frac{1}{4}$ inches; of bill $\frac{5}{8}$ inch; along the ridge $\frac{6}{8}$; along the gape $\frac{5}{16}$ of an inch; across at base $\frac{3}{8}$ through from above down. Tooth situated at $\frac{1}{4}$ inch

from point of bill. Tarsus rather more than $\frac{3}{4}$ inch in length. Tail $2\frac{6}{8}$ inches long. Wings from flexure $3\frac{1}{8}$ inches.

8. *Pygorynchus Gouldii, a new Echinus from the Millstone Grit of Georgia;* by M. Bouvé, (Proc. Bost. Soc. Nat. Hist., Dec. 1846, p. 192.)—Above, conico-convex, a little more sloping posteriorly than anteriorly. Margin somewhat rounded, except near and under the anus, where by an excavation or depression it becomes acute. Inferior surface sub-circular. Mouth situated about one-third of longitudinal diameter from the anterior margin. Apex sub-central, a little anterior, but not so much so as the mouth. Ambulacra radiating at unequal angles, the interambulacral spaces dividing the three anterior from the two posterior, being wider than the rest. The pores of each diverge considerably from the apex, becoming quite dilated a short distance from it, then converge as they descend, until about two-thirds the distance from the summit to the margin, where they are very limited in width, and where the double rows become single. On the margin they again slightly dilate, and are readily traceable to their termination about the mouth, where they are prominent. The anterior ambulacrum is much narrower than the rest. Anus transverse, and situated at about one-fifth the distance from the posterior margin to the apex. Whole length, as shown by three individuals examined, $1\frac{7}{8}$ inches, greatest width $1\frac{3}{4}$ inches, height 1 inch. Locality, Baker County, Georgia. Description of characters from specimens in Cabinet of the Society.

I have named this beautiful species after my respected friend, Dr. Augustus A. Gould.

IV. Meteorology.

1. *Meteorological Observations at Waioli,* on Kauai, one of the Hawaian Islands: from April 1st, 1845, to March 31st, 1846;* by Edward Johnson, Missionary of the A.B.C.F.M.—(Communicated.)

	FAH. THER.						WINDS.				WEATHER.								
Months and date.	Average at 5½ A.M.	Average at 1 P.M.	Average at 6½ P.M.	Maximum.	Minimum.	Mean.	N. E. Trades, A.M.	N. E. Trades, P.M.	Variable, A.M.	Variable, P.M.	Fair, morning.	Fair, P.M.	Cloudy, A.M.	Cloudy, P.M.	Showers, A.M.	Showers, P.M.	Rain, A.M.	Rain, P.M.	Rain at night.	Rain in inches and tenths.
April, 1845,	66·0	75·0	70·0	82·0	62·0	70·2	21	20	10	11	9	4	4	11	10	9	7	6	17	14·0
May, "	69·6	80·3	74·0	85·0	66·0	74·6	27	27	4	4	11	10	5	4	14	15	1	2	10	6·0
June, "	71·6	82·6	75·0	90·0	66·0	76·4	25	27	5	3	16	17	2	1	10	10	3	3	12	4·6
July, "	72·0	82·0	75·8	86·0	69·0	76·3	30	30	1	1	9	7	7	6	9	16	6	2	21	8·0
August, "	71·6	83·2	76·9	89·0	67·0	77·2	29	29	2	2	19	15	2	5	7	8	3	3	12	5·5
Sept. "	71·4	82·6	76·6	87·0	68·0	76·8	28	27	2	3	16	12	3	4	11	13	0	1	14	5·4
Oct. "	69·6	78·5	73·8	84·0	64·0	74·0	18	16	13	15	11	10	5	3	9	10	6	8	22	18·4
Nov. "	66·7	78·3	72·0	82·0	57·0	72·3	4	4	26	26	22	19	2	4	4	4	2	3	10	5·2
Dec. "	65·2	75·0	69·0	82·0	57·0	69·7	7	7	24	24	18	19	6	5	6	6	1	1	11	5·0
Jan. 1846,	62·0	71·8	67·9	79·0	54·0	67·2	3	3	28	28	18	17	8	8	1	4	4	3	10	4·6
Feb. "	63·3	73·5	68·4	78·0	57·0	68·4	10	10	18	18	16	14	10	10	0	1	2	3	10	3·0
March, "	63·4	75·8	69·5	80·0	56·0	69·5	18	18	13	13	15	14	6	8	4	4	6	5	16	6·6

Remarks.—By an inspection of the above table, it will be seen that the thermometer was noticed three times each day, viz. at 5 o'clock

* Waioli is in about 22° 15′ N. Lat., and about 160° W. Long., from Greenwich.

30m. A. M., and 1 and 6½ o'clock, P. M. It was suspended in an open lanai, in the shade.

The highest point of the thermometer was 90° in the month of June, and the lowest 54° on the mornings of the 10th and 11th of January. On the 11th of August it rose to 113°, placed upon a tin water-gauge in the sun.

It will be seen that the greatest fall of rain in any one month, was in October; which was 18·4 inches. The greatest amount noticed in any one day, was on the 17th of the same month; which was 2·39 inches.

There was a squall with thunder on the 19th of April, in which a native schooner with six foreigners and one islander were lost, and another considerable blow from the N.W. on the 26th of the same month. There was also a light squall on the 1st day of May.

On the 10th of October, there was a gale from the N.W. at night, and on the next evening there was vivid lightning skirting the horizon from north to west.

Nov. 27th, wind strong from westward. Also, strong from N.W. on Feb. 18th and 19th, and on the three last days of March; on which latter days the surf rolled heavily into our bay.

By the "Friend," printed at Honolulu, I learn, that the American whale-ship Luminary was struck by a severe gale from W.N.W., in N. lat. 33°, long. 177° 20′ W., on the afternoon of March 27th, in which a heavy sea was shipped that took off six men from the deck, and mortally wounded another. The ship was so materially injured as to render it necessary to put back to Honolulu for repairs. This disaster occurred between 1 and 2 P. M., and on the morning of the next day the gale reached this place.

The northeast trades have prevailed 219 days out of the 365. These winds purify the air, and render a summer residence, especially in the more sultry parts of the islands, much more agreeable and healthy than it would otherwise be.

Fair days 170. The weather has been more pleasant, for this place, take the year together, and less rain has fallen, than is usual.

In the columns marked fair, cloudy, showers and rain, there is necessarily some error from imperfect estimates. Yet the aim has been to give the prevailing state of the weather each day.

I may here remark that the Sandwich Islands afford every variety of weather according to the position of the place, and its proximity to mountains; the northern and eastern sides being usually rainy and comparatively cool, while the southern and western sides are warm and dry.

All degrees of temperature may here be found, from the ice-clad tops of Mauna Loa and Mauna Kea, to the scorching sun of Honolulu.

The islands are usually considered healthy, yet almost the whole population of the group were visited by a kind of influenza in April, 1845, that continued through the month. Considerable numbers of the natives died from this attack, and in many other cases other diseases appeared to be aggravated, and death was the result.

Waioli, Sandwich Islands, April 20th, 1846.

2. *On the Amount of Rain and Snow at St. Louis for the years* 1837 *to* 1846 *inclusive;* by Dr. G. ENGELMANN, (communicated.)—Mr. Lyell in his interesting essay on the delta of the Mississippi, in the

January number of the American Journal of Science, has requested observers along the Mississippi to furnish data as to the quantity of rain falling during the year in their respective localities. In accordance with this desire, I here give the result of ten years observation at this place.

Quantity of atmospherical water (rain and snow water) which fell at St Louis, from 1837 *to* 1846.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	May, June, July.
1837,	0·97	1·62	2·84	3·27	3·01	4·15	0·89	2·36	2·83	0·42	2·33	2·31	27·00	8·05
1838,	3·72	1·11	1·51	3·36	1·68	3·73	3·13	4·47	0·06	3·06	2·09	0·44	28·36	8·54
1839,	2·21	2·50	2·60	5·46	7·93	7·26	5·71	2·89	2·45	3·96	2·48	2·00	47·45	20·90
1840,	1·80	1·22	2·10	3·31	4·58	6.27	2·36	7·15	3·96	6·30	1·73	0·71	41·49	13·21
1841,	0·84	0·88	4·99	3·85	2·38	1·67	3·09	5·63	3·22	6·81	5·44	3·92	42·72	7·14
1842,	0·45	3·90	2·21	3·58	3·22	5·12	1·76	2·64	2·17	2·57	2·38	1·69	31·69	10·10
1843,	2·34	1·90	3·49	4·87	4·15	3·95	2·49	1·32	2·19	1·55	4·82	1·72	34·79	10·59
1844,	3·36	1·73	4·84	3·86	11·26	6·85	8·13	0·45	0·30	2·25	1·09	1·61	45·73	26·24
1845,	1·83	1·07	3·48	2·26	4·44	9·93	4·75	6·21	1·03	1·16	1·10	0·93	38·19	19·12
1846,	1·98	1·27	1·27	4·84	3·53	5·21	0·84	4·73	4·84	2·72	2·11	10·89	45·23	9·58
Mean of 10 years	2·050	1·720	2·933	3·866	4·618	5·414	3·315	3·785	2·305	3·080	2·557	2·622	38·265	13·347

Number of days on which it rained or snowed in every month, from 1837 *to* 1846.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	May, June, July.
1837,	6	11	6	5	10	10	8	7	8	5	8	6	90	28
1838,	8	11	5	7	6	8	4	7	1	7	9	5	78	18
1839,	9	5	5	9	10	12	9	5	6	7	8	10	95	31
1840,	9	5	8	11	8	9	10	12	5	7	7	3	94	27
1841,	10	6	12	10	4	9	8	4	4	9	9	7	92	21
1842,	3	8	7	10	8	11	10	7	6	5	7	5	87	29
1843,	6	8	10	9	12	8	6	4	9	8	11	7	98	26
1844,	9	8	15	10	16	14	11	3	3	6	6	5	106	41
1845,	5	6	7	11	6	18	6	12	3	4	5	7	90	30
1846,	8	9	9	12	7	11	4	10	9	9	7	10	105	22
Mean of 10 years	7·3	7·7	8·4	9·4	8·7	11·0	7·6	7·1	5·4	6·7	7·7	6·5	93·5	27·3

It will be observed that the quantity of rain in the first two years is smaller than in any of the following, and it may be that the rain-gauge, then employed, was imperfect; I substituted another one for it, which has been in use ever since. June is almost always the wettest month; and from May to July, not only the greatest quantity of rain is precipitated, but also in the heaviest showers during the shortest time. They are mostly thunder-showers, especially from the middle of May to the middle of June, which is our rainy season. These rains occasion the rise of our streams about that time much more than the melting of the snows in the mountains They wash away the loose particles of disintegrated rocks and loose soil, and carry them down towards the Gulf. The quantity of rain precipitated in these thunder-showers, frequently amounts to one and even two inches in the space of twenty or thirty minutes to one hour; but by far the greatest quantity which has fallen at any one time, during this period of ten years, was observed on the 21st August, 1841, when 4·60 inches were collected in 75 minutes, from $1\frac{1}{2}$ to $2\frac{3}{4}$ P. M.

Observations with reference to the velocity of the current of the Mississippi at this place, the quantity of water passing by during a certain period, and the sedimentary matter suspended in the river water in different seasons, have been undertaken by me, but are not sufficiently advanced to be made public. I may only state, that contrary to the adopted opinion, the velocity of the current of the Mississippi is on an average rather under than over four miles in the hour; and that only at seasons of high water its velocity is increased to over five and even six miles in the hour.

It may not be improper to state here, that the rains of the early summer months have a great and undeniable influence on the health of this region. I have invariably observed that in those seasons when the quantity of rain fallen during the months of May, June and July exceeded a certain amount, say twelve or fifteen inches, the months of August, September and October, but especially September, were rife with all the numberless varieties of intermittents, often of the most malignant character. The tables show that in the years 1839, 1844 and 1845, the number of rainy days in the first named three months were over 30, and the quantity of rain amounted to over 19 inches; when in any of the other seven years, it did not exceed 12 inches. And the autumns of precisely those three years were the most sickly of the whole ten, as the records of our physicians can testify. In the year 1846 on the contrary, when the quantity of rain in the whole year was one of the largest ever observed, and nearly equal to that of 1844, the autumn was comparatively healthy, and the prevailing diseases were of a mild character; and we find in correspondence with this circumstance, and I may say, as the cause of it, the quantity of rain from May to July only $9\frac{1}{2}$ inches.

St. Louis, February 18, 1847.

3. *Meteorological Society in Finland.*—A meteorological association has been lately formed at Helsingfors, as M. Kupffer writes, the principal object of which is to make observations upon the time of flowering and fructification in that high northern latitude. M. Quetelet writing from Brussels on this subject, adds that M. Œrsted recently at that place proposes to establish a similar association (for the observation of periodical phenomena, but especially times of inflorescence) in Denmark.

4. *Auroral Belt.*—A very distinct and brilliant Auroral belt, spanning the heavens from east and west, was seen at various places in the Northern and Middle States, about 10 P. M., April 7, 1847. It lasted from about $9^h\ 40^m$ to $10^h\ 6^m$, and during this time the belt moved southward, the vertex passing from an altitude of about 77° above the N. horizon to an altitude of about 65° above the southern. The width of the belt varied from about 7° at the vertex to 2° or 1° at the extremities. At 10^h, the northern limb touched *Arcturus;* and at this time a westward waving motion began to be noticed in the zone near the meridian. At $10^h\ 6^m$ the zone broke up, revealing within numerous oblique beams. It rallied in part at various times after this, and at $11^h\ 39^m$, a long dim arc could be traced as low down as β and ε *Corvi*. Various observations were made here of the precise time when the northern or southern limb touched some bright star; and persons at other places who have secured similar observations, are desired to communicate them. A fuller account may be given hereafter. [New Haven, Ct.] E. C. H.

V. Astronomy.

1. *The new Planet Neptune.*—The planet discovered by Galle, Sept. 23, 1846, in consequence of the indications furnished by LeVerrier, is by the Russian and German astronomers, denominated *Neptune*, in accordance with the first decision of the *Bureau des Longitudes*, and of LeVerrier himself. It seems probable that this name will be generally adopted.

In a communication published in *The Union*, Febr. 9, 1847, Lieut. Maury, Superintendent of the National Observatory, announces that S. C. Walker, Esq., had discussed the observations thus far made on the new planet, on the assumption of a circular orbit. With the approximate elements thus obtained, La Lande's *Histoire Celeste* was examined, in the hope of detecting former observations of the planet. A star of the 7–8th magnitude, observed May 10, 1795, (p. 158, 8th from top) was found to be within 2′ of the computed path of the planet, and not to be contained in Bessel's zones. On the 2d of February, 1847, Mr. Walker notified Lieut. Maury, by letter, of his expectation that the star would not now be seen. Two days after, Professor J. S. Hubbard examined the region in question, and found that this star was actually missing. Mr. Walker then computed the elements of the planet, assuming for the occasion, that it is identical with the missing star. The elements thus obtained, as well as his previous results, will be found below.

On the 16th March, 1847, Prof. Peirce, of Harvard University, communicated to the American Academy of Arts and Sciences, a more extended notice of Mr. Walker's investigations, together with his own highly interesting deductions. This communication has recently been printed, and occupies twelve pages in the *Proceedings* of the Academy. We regret that we cannot introduce the paper entire, but our limited space permits us to give here only the following observations of Prof. Peirce.

"Mr. Walker concludes by remarking that he has stated all the circumstances known to him favorable or unfavorable to the supposition of identity of the star and planet. The decision of the question must be the work of time. In order to establish the priority in determining these elements if the identity should be confirmed, he had computed his Elements III. upon this hypothesis of identity. The three sets of elements are here given, referred to the mean equinox of January 1st, 1847, and to mean time Greenwich.

Elements of Neptune.		Circular Hypothesis. I.	Elliptic Hypothesis. II.	Elements if the missing star was Neptune. Elliptic Hypothesis. III.
Longitude of perihelion,	π	unknown	unknown	0° 12′ 25″·51
" " ascend. node,	Ω	129° 48′ 23″·16	129° 48′ 23″·16	131° 17′ 35″·80
Inclination.	i	1° 45′ 19″·88	1° 45′ 19″·88	1° 54′ 53″·83
Long. of epoch, Jan. 1, 1847,	ε	unknown	unknown	328° 7′ 56″·64
True heliocentric long. on orbit, Sept. 28, 1847,	w	326° 59′ 41″·50	326° 59′ 34″·74	326° 59′ 34″·74
Eccentricity,	e	0·	unknown	0·0088407
Radius vector, Sept. 28, 1847,	r	29·93995	30·00506	30·02596
True sid. orb mot., "	n	21″·65857	21″·65789	21″·64553
Mean distance,		29·93995	30·200585	30·25042
Mean daily sidereal motion,	μ	21″·65857	21″·37881	21″·32600
Period in tropical years,	T	163y·8253	165y·97030	166y·38134

"Professor Peirce remarked, that the orbits given by Mr. Walker differ so widely from the predictions, that he has been induced to make a careful reëxamination of the observations. He has not only himself verified Mr. Walker's distance of 30, and the consequent angular motion; but Mr. George P. Bond, of the Cambridge Observatory, has also, at his request, verified this distance and motion from the Cambridge observations alone. From these data, without any hypothesis in regard to the character of the orbit, he has arrived at the conclusion, that *the planet Neptune is not the planet to which geometrical analysis had directed the telescope;* its orbit is not contained within the limits of space which have been explored by geometers searching for the source of the disturbances of Uranus; and its discovery by Galle must be regarded as a happy accident. Mr. Adams, in his "Explanation of the Observed Irregularities of Uranus," considered two hypothetical orbits, in one of which the mean distance is 38·4, or just double that of Uranus, and in the other it is 37·6; while M. LeVerrier, in his "Researches into the Motions of the Planet Herschel, called Uranus," after deriving some rough approximations from the consideration of the mean distance 38·4, proceeds to the accurate examination of the three distances 39·1, 37·6, and 36·2. The extension of the investigations to any other mean distances can be made only by assuming a continuous law to pervade the subject of inquiry, and that there is no important change in the character of the resulting perturbations. Guided by this principle, well established, and legitimate, if confined within proper limits, M. LeVerrier narrowed with consummate skill the field of research, and arrived at two fundamental propositions, namely,—

"1st. That the mean distance of the planet cannot be less than 35, or more than 37·9. The corresponding limits of the time of sidereal revolution are about 207 and 233 years.

"2d. 'That there is only one region in which the disturbing planet can be placed, in order to account for the motions of Uranus; that the mean longitude of this planet must have been, on January 1st, 1800, between 243° and 252°.'

"Neither of these propositions is of itself necessarily opposed to the observations which have been made upon Neptune, but the two combined are decidedly inconsistent with observation. It is impossible to find an orbit, which, satisfying the observed distance and motion, is subject at the same time to both of these propositions, or even approximately subject to them. If, for instance, a mean longitude and time of revolution are adopted according with the first, the corresponding mean longitude in 1800 must have been at least 40° distant from the limits of the second proposition. And again, if the planet is assumed to have had in 1800 a mean longitude near the limits of the second proposition, the corresponding time of revolution with which its motions satisfy the present observations cannot exceed 170 years, and must therefore be about 40 years less than the limits of the first proposition. Neptune cannot, then, be the planet of M. LeVerrier's theory, and cannot account for the observed perturbations of Uranus, under the form of the inequalities involved in his analysis.

"It is not, however, a necessary conclusion that Neptune will not account for the perturbations of Uranus, for its probable mean distance

of about 30 is so much less than the limits of the previous researches, that no inference from them can be safely extended to it. An important change, indeed, in the character of the perturbations takes place near the distance 35·3; so that the continuous law by which such inferences are justified is abruptly broken at this point, and it was hence an oversight in M. LeVerrier to extend his inner limit to the distance 35. A planet at the distance 35·3 would revolve about the sun in 210 years, which is exactly two and a half times the period of the revolution of Uranus. Now, if the times of revolution of two planets were exactly as 2 to 5, the effects of their mutual influence would be peculiar and complicated, and even a near approach to this ratio gives rise to those remarkable irregularities of motion which are exhibited in Jupiter and Saturn, and which greatly perplexed geometers until they were traced to their origin by Laplace. This distance of 35 3, then, is a complete barrier to any logical deduction, and the investigations with regard to the outer space cannot be extended to the interior."

2. *New Comet*, (Proceed. Amer. Acad.)—A telescopic comet was discovered near the star 18 Andromedæ, on the evening of March 4, 1847, by Mr. Geo. P. Bond, at the Observatory in Cambridge, Mass. Its place March $4^d\ 8^h\ 40^m\ 09^s$, was R. A. $23^h\ 35^m\ 50^s{\cdot}5$, and decl. $+50°\ 1'\ 46''$, referred to mean equin., Jan. 1, 1847. It was quite bright, and nearly visible to the naked eye. On the 8th inst. it was visible to the eye as a star of the 5th or 6th magnitude. The elements of this comet have been computed (1) by Prof. Peirce from places of March 4, 5, 6, and (2) by Mr. Geo. P. Bond, from places of March 5, 12, 19, the latter taking into account the small corrections.

	(1.)	(2.)
Per. pass. - -	Mch. 31·907 Gr. m. s. t.	Mch. 30·3369
dist. - - -	0·04444	0·0445986
Long. of asc. node, -	10° 13′	21° 06′ 46″
" perihelion, -	256 33	275 16 22
Inclination, - - -	48 53	48 41 49
Motion, - - -	direct,	direct.

This comet is supposed to be identical with that detected Feb. 6, 1847, in *Cepheus*, by Mr. J. R. Hind, at London.

3. *Expected Return of the Comet of* 1556.—We are indebted to John Taylor, Esq., of Liverpool, for several interesting astronomical notices published by him during the past year in the public prints of that city. Most of them relate to subjects which have already been brought forward in this Journal; but we have not hitherto referred to the approaching expected return of the comet of 1556, with the discussion of which one of these notices is occupied. As long since as 1751, Mr. Richard Dunthorne, of Cambridge, on computing the elements of the comet of 1264, found them so similar to those of the comet of 1556, that he was led to the conclusion that the two were identical, and that its return might be expected about 1848. Subsequent investigations which have been made by different astronomers, confirm this conclusion; and there is, therefore, good reason to look for the reappearance of this comet during the year 1848, although it would not be surprising if this event should happen even a year earlier or later than this date.

4. *Parallax of a Fixed Star in Ursa Major*, (Comp. Ren., Aug. 31 and Dec. 7, 1846.)—A star of the 7th magnitude, No. 1830 of Groombridge's Circumpolar Catalogue, has according to Argelander a proper motion of seven seconds of arc per annum, which is greater than that hitherto recognized in any other star. M. Faye, of Paris, by a course of careful observations on the positions of this star with reference to a star of 9–10th magnitude, (whose R. A. is about 30′ greater, and declination about 40″ less)—assuming, on good grounds, that the parallax of the latter is nearly or quite insensible—has determined in a manner which appears quite satisfactory, that the parallax of the former (viz. 1830 Groombridge) is 1″·06. The distance of this star from our sun is, therefore, about 195000 times the radius of the earth's orbit;—a space which would require three years for light to traverse.

5. *Planetary Nebulous Masses near the Sun.*—It is well known that in total eclipses of the sun, there have been often seen conical protuberances of a red color, projecting from behind the disc of the moon. This phenomenon was very conspicuous in the total solar eclipse of July 8, 1842,* and M. Arago has collected many cases of the same kind and printed them in the *Annuaire* for 1846. M. Babinet has published a memoir on these phenomena,† in which he explains them by the supposition, that there are very near the sun, planetary masses, revolving around that body with great rapidity. These incandescent, flame-red, vapory masses, having the form of circular trains more or less elongated, with the sun for their centre, cause the different appearances, which are mentioned in the accounts of total solar eclipses, as *fiery mountains*, *sheafs of flames*, &c. The greatest elongation hitherto observed in any of these bodies is 5′, which would show that this one must revolve around the sun in about four hours.

This hypothesis, although ingeniously supported by M. Babinet, is open to objection, and many more observations will be needed before it can be considered as any thing more than plausible.

VI. Miscellaneous Intelligence.

1. *Relative Level of Lake Ontario;* by C. Dewey.—In 1845, from June 1st to December 31st, the water of this lake *fell two feet and three inches.* Observations on the level have been continued through 1846, which show that the water gradually rose from February to June, *fifteen* inches, though it was then fifteen inches lower than in June, 1845. From July it gradually fell to November, when it was *two feet* lower than in June, 1845, while it was about the same level as in November, 1845. Through November, owing to the fall rains, it gradually rose, but at the end of 1846, it was the same as in December of the previous year, at least two feet lower than in the summer of the year before.

The difference in the quantity of water that falls in snow and rain, must account for the fall of the lake. The water is below its usual level through all the great lakes to Lake Superior.

2. *Inhalation of Ether in Surgery.*—This new discovery, which promises to relieve the world to a great extent of pain in surgery, has

* See Baily and Airy, Trans. Astr. Soc., Vol. xv, pp. 1, 9.
† Comptes Rendus, Feb. 16, 1846, pp. 281–286, 4to.

found much favor abroad, and we give the following from among the testimonials which have reached us. It is cited from the Athenæum, for Jan. 30, 1847, and credited by this paper to the Lancet, Jan. 16 and 23, the Medical Gazette, Jan. 22, and Medical Times, Jan. 16 and 23.

The practicability and utility of the American discovery of the employment of the vapor of ether in surgical operations is no longer a matter of doubt. Since our first notice of the subject, hundreds of operations have been performed in this country without pain. We would point out, incidentally, the very different nature of the evidence on which we pronounce the verdict of success, from that of the testimony brought forward to support the claim of Mesmerism to be regarded as a means of making surgical operations painless. We allude to this because we see that those who still amuse themselves with mesmeric phantasies regard the state induced by the action of ether as analogous to the mesmeric sleep. Surely, it must by this time be evident to all but prejudiced observers, that had there been a particle of truth in the allegation of painless operation under the influence of mesmeric sleep, medical professors would most gladly have availed themselves of its services.

To return, however, to the ether. The inhalation of gases as a means of treating disease is, it appears, not new in the medical profession. It was carried to a great extent by Dr. Beddoes; but has been comparatively little employed in the recent practice of medicine and surgery. That such gases produced various powerful effects on the nervous system has also been well known: and to this day it is a common practice in our chemical lecture-rooms to administer, by way of amusement to the pupils, nitrous oxyd, or laughing gas, on account of its influence on the nervous system. It has also been known for a length of time, that the vapor of ether, when taken into the system, produces an effect upon the nervous system which has been stated to be analogous to the action of the laughing gas. This, however, is now seen to be a mistake; as the amusing influence of the laughing gas is found to arise out of its action on that system of nerves which supply the muscles of the body—occasioning an increase of their activity; so that persons who have breathed it have a tendency to running, jumping, fighting, laughing, and other motions of the muscular system. The action of ether, on the other hand, is chiefly manifested by its influence on those nerves which are devoted to the function of sensation.

For the application of the vapor of ether to the human system for the purpose of producing insensibility we are indebted to Doctors Morton and Jackson,* of Boston, in the United States; and we believe we may congratulate these gentlemen on having made the most important discovery which has been contributed to medicine since that of vaccination by Jenner. The medical journals quoted at the head of this article report a large number of cases which sufficiently attest the value of this agent—not only in the minor operations of surgery, such as the extraction of teeth,—but also in the most tedious and distressing, and those involving the greatest amount of danger from the shock given to

* Dr. Morton, whose name is here mentioned, received his first information on the subject from Dr. Jackson.

the nervous system. Mr. Lawrence gives an account of one which he characterizes as "one of the most painful surgical operations,"—and which consisted in extirpating the eye-ball for the cure of malignant disease. This was performed with so little pain, that the patient, after recovering from the effects of the ether, did not even know that the operation had commenced.

At the same time that the success of this application has been far greater than could have been anticipated, there have, however, been failures; which prove the necessity of attention on the part of those who employ it. The mode of administering the ether hitherto adopted has been that of introducing into the lungs, by means of a tube, the vapor of sulphuric ether mixed with atmospheric air. Now, although at first sight this would seem a very simple process, there are several points which appear to require attention. In the first place, the apparatus may be so imperfectly constructed, or persons may so mismanage it, that too large or too small a quantity of vapor will be supplied to the system. In the first of the cases, the patient becomes choked—in the last, he does not take a sufficient quantity to produce the effect sought. In the second place, atmospheric air becomes saturated with very different quantities of the vapor of ether at different temperatures. Thus, 100 cubic inches of air saturated with ether at 40°, contain 24 cubic inches of ether; but the same quantity of air at 70° contains 49 cubic inches of the same. This demands attention: but the proper temperature of the room for the best success may be easily ascertained, and regulated with a little care. Another point which may interfere with the action of ether, is the presence of alcohol. Ether is formed from the decomposition of alcohol by sulphuric acid: and unless great care be exercised in its preparation, this substance will be present; and the commercial ether is often largely adulterated with alcohol. The effect of the vapor of alcohol is very different from that of ether—if it be not in the early stages of its action of a directly opposite nature. A fourth point demanding caution, arises from the peculiarly inflammable nature of etherous vapor. Should this agent be employed by careless persons during candle light, it may, from its highly inflammable nature, explode; and from the consequences of that explosion it does not appear evident that the person breathing the vapor would escape—although we have heard of no accident of this kind at present.

The effect of the vapor of ether upon the system seems to be the same as that of an overpowering quantity of alcohol; and as a proof that the effects are the same under other influences, Mr. Lawrence relates a case in which he performed amputation of the leg upon a woman who was intoxicated, and who knew nothing of the matter until she became sober. There is, however, this difference between the action of alcohol and that of the vapor of ether—that with the former the stage of insensibility is preceded by a stage of nervous and vascular excitement, whilst in the latter the insensible state comes on almost immediately. In the numerous cases which have been reported, the ether appears to have had different effects upon the nervous system;—and this has probably been owing to the quantities of the vapor inhaled. Thus, in several cases the effect has been to deprive the patients

of the power of feeling and moving; but they have been conscious all the time, and have witnessed every step of the operation performed on them—though without experiencing pain. In one case, this was rather ludicrously illustrated:—the patient during the operation "giving sly winks and facetious nods to those surrounding him. During the intervals of the inhalation his observations were of the most facetious character—forcing from the bystanders involuntary laughter, and converting that which was to the poor fellow a most tragic event into a scene little short of a farce." In other cases, consciousness is less evident,—but not wholly extinguished. One person during the extraction of a tooth imagined that he was contending with a wild beast—which he thought he had overcome when the tooth was extracted. Another, during the amputation of her leg, "thought she had been in a dream; and that we had hurt her leg to see if she could bear the operation which was to be performed the next day." In the majority of cases, however,—and these probably where the ether has been most adroitly administered,—there has been a total loss of consciousness; and the patients on waking up from the slumber produced, have expressed their surprise not only at the operation being over, but at the apparently short time which it has occupied. Thus, in the operation related by Mr. Lawrence, the patient "expressed a fear that he had not had enough of the ether to produce the desired effect. When told that the operation had been performed, he said—'Operation! operation!—what operation?'—and seemed quite puzzled." This is, undoubtedly, the most desirable state to produce.

The question will now occur—"Are any ill effects to be apprehended from the action of this new agent?" As far as we have seen, or been able to inquire, no after consequences have occurred to occasion any fears where the vapor has been administered with proper precautions by an intelligent medical practitioner. Although the effects on the system may be compared to those of a large dose of alcohol, comparatively little of the excitement and consequent exhaustion dependent on the administration of the latter agent are felt with the ether:—so that no patient need have any hesitation in taking it.

There is another interesting field for inquiry to the medical man in relation to the use of ether; and that is in diseases of the nervous system. We cannot but think that an agent so powerful might be applied with success in arresting some of those diseases of that system in which narcotics are found beneficial; and if not capable of curing, it might at least assist the cure by relieving pain.—We have felt it our duty to give our readers this sketch of the history and action of this new remedial agent: in order, on the one hand, to prevent accidents and failure by its use in the management of unskilful persons—and on the other, to remove any unnecessary doubts or alarm which might be felt by those who would seek relief through its employment.

3. *On the Nile;* by Dr. C. T. Beke, (Geograph. Soc., Dec. 28 and Jan. 11.—Athen., Nos. 1001 and 1004.)—The obscurity which has so long hung over the sources of the Nile, is, to a great extent, dissipated by the trouble which Dr. Beke has taken to clear up the ambiguities of conflicting statements, and re-establish facts long misunderstood. A careful sifting of the writings of both ancient and modern travellers in

regard to the sources of the Nile, together with his own intimate acquaintance with the country watered by a great number of the primitive tributaries of the great river, have enabled him to unravel the entanglement which obscured the subject, and to present a statement so clear and satisfactory as to leave little labor for future investigators. The Doctor first ascends the Takazie—the Artoborus of Ptolemy—and minutely describes its various affluents: after which, coming back to the Nile, he ascends it to the junction of the Blue and White Rivers. Going up the Bahr el Azrek, or Blue River, he comes to a spot where M. Caillaud speaks of the Hessen as coming from the S.E.—which Dr. Beke proves to be the Abaï of Abyssinia; and he, at the same time, shows that the river described by Mr. Russegger as the upper course of Bahr el Azrek, is in fact the Dedhesa,—a stream first made known by Dr. Beke, and which he now identifies with the Takui, described by De Barras as the great western arm of the Nile; under which name the Portuguese understood the Blue River,—since the White River, or Bahr el Abiadh, was entirely unknown to them. After describing all the affluents of the Abaï on both sides, Dr. Beke notices a new river which has of late years appeared in the maps under the name of Habahia,—and which has been supposed by some geographers to be either the upper course of the Kilimaney (Quilimané) or of the Bahr el Abiadh; but which Dr. Beke shows clearly to have no separate existence —it being in fact nothing but the Abaï of Abyssinia, called by the Gongas Abbaya. Dr. Beke next discusses the subject of the Maleg—a river which was crossed by Fernandes, in 1613, on his way to Guárea; and shows that the route taken by the Jesuit missionary has been altogether misunderstood by Bruce. Leaving the Abaï, the Doctor next takes up the Dedhesa; and enumerates its tributaries on both sides,—as he had done with the other great rivers, the Takazie and the Abaï. Having thus exhausted the hydrographic basin of the Blue River, the author, before commencing the particular investigation of the course of the White River, enters into a comparison of the two great arms of the Nile—the White and Blue Rivers: and, after minutely examining the evidence, both ancient and modern, on the subject, concludes in these words: "Thus, whether we consider the relative magnitude of the two rivers, the direction of their respective beds, or the volume of their waters—whether we regard the opinions of the ancient geographers, or those of modern travellers, or of natives acquainted with *both* streams (for the evidence of such as only know one is of course inadmissable) the result is the same. In all and every of these points of view, the Bahr el Abiadh, or White River, is the principal stream—and the Bahr el Azrek, the subordinate or affluent."

The author now took up the White River, or main stream of the Nile. Our knowledge of the upper course of this river has been obtained from the exploring expeditions ordered by the present ruler of Egypt. On its right bank it receives, in about the 9th parallel, a large river called the Telfi or Sobat,—which Dr. Beke identifies with the Godjeb; and he then enters into a minute detail of the affluents of this river on both sides. Among these, it will be sufficient to allude to the Baro and Bako, which join it on the right side, and the various streams bearing the common name of Gibbi, which fall into it on the

left bank. The Godjeb has been presumed to be the upper portion of the Jub or Gowind, which falls into the Indian Ocean near the line; but subsequent information shows this opinion, which originated in Dr. Beke's own information, to be untenable: indeed, M. D'Abbadie positively considers it to be the head of the Nile. The second Egyptian expedition ascended the main stream of the Nile as far as 4° 42′ 42″ N. —at which point our positive information ceases; but from the information collected by M. d'Arnaud and M. Werne, who accompanied the expedition, Dr. Beke shows the existence of another great arm of the Nile, called the Shoa Berri; which, like the Abaï and Godjeb, joins the main stream from the S.E., and exhibits the remarkable spiral course common to those rivers, with many others of the Abyssinian plateau. As regards the main stream, Dr. Beke, from a comparison of various authorities, both ancient and modern, carries the Nile up to the country Mono-Moézi; and, in fact, shows the great probability of its being a continuation of Lake N'Yassi, the Maravi or Zambezi of the old maps. In the name Mono-Moézi, Dr. Beke finds the origin of the name Mountains of the Moon; in which, according to Ptolemy, the Nile has its rise: the word Moézi meaning *moon* in the language of that country, as well as in those of the whole of Central Africa. The author next proceeds to consider the physical character of the country in which the eastern tributaries of the Nile have their origin; and which he shows to be an elevated table-land, having an abrupt declivity towards the sea-coast, and a very gradual slope landwards down to the Nile, which skirts its base; and the ridge of which has an elevation of from 8,000 to 9,000 feet above the ocean, independent of isolated mountain masses which attain a height of from 11,000 to 15,000 feet.

4. *Water raised by Waves through Valved Tubes*, (Athen., No. 1001.)—A feasible and obvious application of Harvey's grand discovery of the use of valves in raising the blood through the veins, has just been suggested by a correspondent of the *Mechanics' Magazine;* namely, the raising of water from the sea, by the lash of the waves through valved tubes into reservoirs on a high level,—for the acquisition, of course, of an unlimited supply of water power, to be turned to any requisite purpose. The inventor proposes to test the practicability of this kind of Water-Ram on Southsea Beach.

5. *Electric Telegraph;* Fact *v.* Fancy, (Athen., No. 1001.)—A passage in No. 241 of the "Spectator," offers a curious example of a matter treated by an enlightened writer of the time as a piece of fabulous extravagance, yet more than realized in one of the most extraordinary applications of modern science:—"Strada, in one of his prolusions, gives an account of a chimerical correspondence between two friends by the help of a certain loadstone,—which had such virtue in it that if touched by two several needles, when one of the needles so touched began to move, the other, though at ever so great a distance, moved at the same time and in the same manner. He tells us that two friends, being each of them possessed of these needles, made a kind of dial-plate, inscribing it with twenty-four letters—in the same manner as the hours of the day are marked upon the ordinary dial-plate. They then fixed one of the needles on each of these plates in such a manner that it could move round without impediment, so as to touch any of the

twenty-four letters. Upon their separating from one another into distant countries, they agreed to withdraw themselves punctually into their closets at a certain hour of the day, and to converse with one another by means of this invention. Accordingly, when they were some hundred miles asunder, each of them shut himself up in his closet at the time appointed, and immediately cast his eye upon his dial-plate. If he had a mind to write any thing to his friend, he directed his needle to every letter that formed the words that he had occasion for—making a little pause at the end of every word or sentence, to avoid confusion. The friend, in the meanwhile, saw his own sympathetic needle, moving of itself to every letter which that of his correspondent pointed at. By this means, they talked together across a whole continent and conveyed their thoughts to one another, in an instant, over cities or mountains, seas or deserts."

6. *Dilatation of Ice;* (Proc. of the Acad. Sci. at St. Petersburg; L'Institut, No. 680, Jan. 13, 1847.)—Heinrich, in 1807, determined by direct experiment, that the coefficient of dilatation for ice was 0·00245, or $\frac{1}{408}$ its length, between 0° and 80° R. This result has been adopted in the interesting researches on glaciers, by Agassiz, Forbes, and others. Under the direction of M. Struve, recent experiments have been made with great care by Lieut. Schumacher of Denmark, (then at Pulkova.) They embraced one hundred and fifty three measurements, between the 11th of February and 24th of March, 1845, for all temperatures from −1° to −22° R., and from degree to degree. The observations were divided into three series; and the mean of the three afford for the linear dilatation of ice between 0 and 80° R. $\frac{1}{191}$, which is more than double that obtained at Ratisbonne. It has also been found that between the temperatures stated, the dilatation is perfectly uniform.

7. *Measure of a Degree of a Meridian in Finland*, (Proc. of the Acad. Sci. of St. Petersburg; L'Institut, No. 681, Jan. 20, 1847.)—The measure of a degree of the meridian in Finland between the island of Hochland and Torneo is finally terminated after fourteen years of severe labor. The chief merit of the great work is due to M. Woldstedt, who has had almost the sole charge since 1836, and has consequently devoted to it ten years of his life. At Torneo, they met the Swedish savants charged by government with an examination of the country between Pahtawara and Laponia and the frontier of Norwegian Finmark. They have already completed their triangulation to Kautokeino, and will soon begin a second line and extend along the coast of Norway between Kautokeino and the North Cape.

8. *Middendorf's Siberian Explorations.*—M. Middendorf, aided by learned friends, is actively engaged with the account of his important expedition, and the Academy of Sciences has been charged to advise as to the means and style of publication.

M. Keyserling is occupied with the fossils collected on the late Siberian expedition under Middendorf.

9. *Bear River Springs, Rocky Mountains*, (Expl. Exped. of Capt. Fremont, and this volume, page 198.)—The temperature of the Beer springs, as observed by Capt. Fremont, was 65° F., at sunset, that of the air being 62°·5. The elevation above the Gulf of Mexico was 5840

feet, or about 500 feet lower than the Boiling springs which are of a similar nature at the foot of Pike's peak on the Fontaine-qui-bouit. On the morning of the next day, (July 26,) the temperature of the large Beer spring was 56°, and that of the Steamboat spring 87°; and that of the steam hole, near it, 81°·5. Farther south on the great salt lake, about seven miles from Clear creek, ten or twelve hot saline springs were observed by Capt. Fremont, in one of which the thermometer stood at 136° and in another at 132°·5.

10. *Chalk and Coal Fires*, (Athen., No. 1001.)—The practical utility of chalk as an article of fuel has been tested within the last few weeks, according to a Salisbury paper, and with the most satisfactory results. Surrounded with coal, it gives a strong heat, and a clear fire, at half the usual expense; so that to the poor, in the chalk districts, it must be an invaluable boon.

11. *Paris Academy of Sciences.*—The following vacancies occasioned by death have lately been filled: M. Fontanier, the French consul at Singapore, has been elected in place of Dubois-Aymé; Panofka of Berlin, in place of Ideler; M. Faye, the Astronomer, in place of Damoiseau.

12. *A Society of Naturalists* has been formed at Trieste, with special reference to the zoology of the Adriatic. Count Odonel has been appointed President.

13. *New Appointments to Professorships in Harvard and Yale.*—Mr. E. N. Horsford has been elected to fill the chair of the Rumford Professorship of Science applied to the Arts, in Harvard University, and Prof. Jeffries Wyman, M.D., has been chosen Hersey Professor of Comparative Anatomy in the same Institution.

Mr. John P. Norton has been appointed Professor of Agricultural Chemistry and of Vegetable and Animal Physiology, in Yale, and B. Silliman, Jr., Professor of Chemistry applied to the Arts.

14. *Deviation of a Falling Body.*—In the remarks on the *deviation of a falling body to the south*, in our last number, it was not considered that the deviation to be accounted for, is that south from a plumb line. The cause there assigned, viz. the earth's rotation, makes the plumb itself deviate to the south of the line of the earth's attraction, as much as the falling body.

Corrections.—We have been informed by Dr. Engelmann, that since the publication of his notice of the Melonites (*p.* 124), he has ascertained that Dr. Prout first directed Dr. Brown's attention to the locality mentioned, and the latter discovered the fine slab now in possession of the Academy.

In the figure of the Marsileæ of North America, page 55, of this volume, the body of the capsule of *fig.* 1, should have been represented as more connected with the stipe so as to make the raphe much longer. All the figures are twice not *half* the natural size.

On page 299, in the notice of Dr. Peter's work on Urinary Calculi, "Pennsylvania" is inserted incorrectly for "Transylvania."

In Volume i, of this series, page 427, under "Electric Excitement of Paper," the word *store* should be substituted for stone.

15. Obituary.—*Dr. Amos Binney.*—Science has been called upon to lament the loss of one of her most zealous and efficient votaries in America, Dr. Amos Binney of Boston. In New England especially his aid and influence were preëminent.

After concluding his college course at Brown University, he studied Medicine, but never entered upon its practice, his relations in life and his tastes leading him rather to mercantile pursuits, which he prosecuted successfully.

He early manifested a love for natural science, and was one of the first who cultivated the branches of Mineralogy and Conchology among us. But his general researches extended over the whole field of Natural History. He was one of the founders of the Boston Society of Natural History, and his large and valuable collections of minerals and shells formed the basis of its Cabinet. At the time of his death he was its President, and was also chosen to preside over the "Association of American Geologists and Naturalists," at the coming meeting to be holden in Boston in September next.

He contributed several papers on Conchology to the "Boston Journal of Natural History," a work which was modelled under his direction. For several years he had been engaged in a work on the Terrestrial Mollusks of the United States, which he had not quite completed; but which is believed to be in such a state as to be readily terminated by some other hand. To render this work as complete as possible, he had employed a skillful collector for two winters in exploring Florida and the Southwestern States, including Texas. He intended that in fullness of detail and in beauty and accuracy of execution, it should not be surpassed by any other work.

He had amassed what he regarded as a competency, and intended to devote his future days more especially to scientific pursuits. His health having become enfeebled during the last summer, he resolved on a tour to Europe for the double purpose of regaining his health and of visiting scientific men and collections, and also of enlarging his library, already the most valuable private library of Natural Science in America. He sailed for Europe in November last; but his malady rapidly gained the ascendancy over him, and he died at Rome, Feb. 18th, aged forty-three years.

His loss will be felt with peculiar severity by his fellow laborers in the common cause in Boston, where from his wealth, liberality and knowledge of human nature, his influence—always on the right side—was very great.

16. *Bory de St. Vincent*, a military officer of distinction, and also a name well known in science for his various contributions, has lately died in the 66th year of his age.

VII. Bibliography.

1. *Eulogy on John Pickering, LL.D., President of the American Academy of Arts and Sciences, delivered before the Academy*, Oct. 28, 1846. pp. 106. Cambridge University Press.—Never was an eloquent and glowing tribute of admiration and affection to the memory of a great and excellent man better deserved than in the present instance. It is a beautiful biographical eulogy, replete with interesting facts, relating to the life and labors and achievements of a scholar who has not had his superior, if his equal, in this land; of a jurist and counsellor of a high order of talent and learning; of a patriot and philanthropist whose efforts and aspirations were indeed first for his country and next

for his race—with a purity and perseverance never surpassed; and finally, his moral and social character in all the relations of life presents a noble example for the imitation of youth and age.

Judge White has presented his subject with the chastened elegance and dignity of style and composition which, as a scholar of a high order, he never fails to do when he appears as a writer. His fine classical eulogy upon the late Dr. Bowditch is still fresh in our recollection—and the names of BOWDITCH, PICKERING, STORY, and SALTONSTALL, are honor enough for the good old town of Salem, although she can present others of no small celebrity among both the living and the dead.

The eulogium of Judge White upon the late Dr. Bowditch* called forth from us the following remarks. "The eulogium of Judge White is a delightful composition, replete with eloquence and literary beauty, and warm with affectionate respect for the great man whom it commemorates. Being the production of a townsman and cotemporary, it presents graphic sketches of his life and character both in the forming and mature stages, and does equal honor to the head and heart of the writer and to his noble subject." All this is strictly true in the case of Mr. Pickering. In this brief notice it is impossible to say anything definite of his wonderful labors. They fill us with astonishment, not to say with self-reproach, when we see how much was done and well done by this extraordinary man within the allotted period of human life, for he died in his 70th year. We will venture to present the following extract of a letter from a mutual friend, himself a man of high attainments in science and arts. It is dated Aug. 23, 1846, in reply to one from the senior editor.

"It has been your good fortune to have known and been connected with the 'good of old,' and to have enjoyed the society of their descendants—a rare privilege. You could therefore better judge, whether the noble traits in the character of the father† had been diminished in their transmission to the son. I think that those who did not daily mix their walks with his walks would not form a sufficiently high estimation of his character, as a man and influential member of society. His reputation was more decidedly European than American. The studies of his later years called forth the exercise of the highest powers of intellect; yet he went to his books for relaxation, and while incessantly engaged and overtasking his physical strength, always spoke of them as affording amusement. Lepsius addressed him from the foot of the pyramid of Cheops on abstruse points in the Egyptian dynasty history, and he replied with the promptness of one whose knowledge was at instant command. He, in his last hours, was much excited by any new fact, or inferences growing out of investigation now in progress in Egypt, and seemed to feel that a flood of light would soon burst upon us from that quarter. I have for many years enjoyed a familiar intimacy with him, and the great advantage of knowing through him interesting details in connection with his prospects. A few weeks before his death, he placed in my hands papyri from Thebes, which he

* Am. Jour., Vol. xxxv, p. 386.

† The late Col. Timothy Pickering, a companion of Washington in the war of the Revolution and the first Secretary of State under the constitution during the administration of Washington, at Philadelphia.

wished unrolled, as he considered, from the ancient language in which they were written, that they might be important."

We presume they were the papyri mentioned by Judge White, which proved to be an Egyptian deed of land in Thebes, duly signed, sealed and recorded in the Greek language.

2. *Botany of the Northern States.*—Prof. A. GRAY, of Cambridge, will publish in a few days, a Manual of Botany of the Northern States, extending to Ohio and Wisconsin. This work, of which we have had a glance whilst passing through the press, will prove an invaluable acquisition to all students of our indigenous plants. On the one hand, the language employed is so studiously simple and popular as to be almost divested of technicality; whilst on the other, it is as rigidly exact and scientific as the more elaborate works of the well-known author. It has the further great recommendation of being so compendious and portable, that it may be carried in the pocket, for reference in the fields. In schools and colleges, where "The Botanical Text-Book" of Prof. Gray is now becoming generally introduced, this Manual, its indispensable accompaniment, cannot fail to be appreciated alike by teachers and students; as the succinct descriptions of all the wild plants, upon the system and classification of the Text-Book, will at all times enable the learner practically to apply its scientific principles for himself.

3. *Palæontology of New York;* by JAMES HALL.—The sheets of the first volume of Mr. Hall's Report on the Palæontology of New York, have reached us at a late hour, and we have barely space to announce the publication of this important work. It has been looked for with much interest, and we believe that its high character will fully satisfy the expectations that have been excited by the distinguished reputation of the author.

4. *Lyceum of Natural History of New York*, Vol. iv, Nos. 8 and 9.—These numbers conclude the fourth volume of the Transactions of the Lyceum of Natural History of New York. It is occupied with a continuation of the elaborate catalogue of Geodephagous Coleoptera of the United States, by M. John L. LeConte of New York. This catalogue is enriched with various annotations, and with detailed descriptions of species of the following genera:—Myas, Stomis, Isopleurus, Percosia, Celia, Amara, Triæna, Acrodon, Bradytus, Curtonotus, Euryderus, Geopinus (n. g.), Agnoderus, Cratacanthus, Piosoma (n. g.), Amphasia, Spongopus (n. g.), Anisodactylus, Eurytrichus (n. g.), Selenophorus, Pangus, Harpalus, Geobænus, Gynandropus, Stenolophus, Acupalpus, Aepus, Eraphius, Anophthalmus, and Lachnophorus.

5. *Journal of the Boston Society of Natural History*, Vol. v, No. 3.—

F. ALGER, Notices of New Localities of rare Minerals, and reasons for uniting several supposed distinct species: p. 297.

H. D. and W. B. ROGERS, On two remarkable Trains of Boulders in Berkshire, Massachusetts: p. 310, with a plate.

J. P. KIRTLAND, M.D., Description of the Fishes of Lake Erie, the Ohio River, and their Tributaries: p. 330, with four plates.

J. LEIDY, Anatomical description of the animal of the Littorina angulifera: p. 344, with figures.

ASA GRAY, Notice of a New Genus of Plants of the Order Santalaceæ: p. 348.

N. M. Hentz, Descriptions and Figures of the Araneides of the United States: p. 352, with two plates and numerous figures.

J. E. Teschemacher, On the Fossil Vegetation of America: p. 370, with plates.

J. Hall, On the Geological Position of the Cranium of the Castoroides Ohioensis, and J. Wyman, M.D., Anatomical Description of the same: p. 385, with three plates.

J. Bacon, Jr., Polythalamia in sand from the Sahara Desert: p. 402, with figures.

C. T. Jackson, M.D., Chemical and Mineralogical Fragments: p. 405.

J. B. Forsyth, On the Habits of Salmo fontinalis: p. 412.

S. Cabot, Jr., M.D., Description of Pyranga roseo-gularis: p. 415.

H. Berghaus and A. K. Johnston: The Physical Atlas; a series of maps illustrating the Geographical Distribution of Natural Phenomena;—of races, languages, rain-regions, deserts, mountains, rivers, magnetic phenomena, of volcanic action, and plants and animals over the globe. The Philosophical Magazine closes a detailed notice of this Atlas, a copy of which has not reached us, by saying, "we feel bound both in justice to the editors and our readers, to give it our warmest recommendations."

R. I. Murchison: The Silurian Rocks of Parts of Sweden; 48 pp. 8vo. *London*, 1847.

R. Patterson: Introduction to Zoology, for the use of schools. 12mo. *London*, 1846.

J. Nicol: Guide to the Geology of Scotland. *Edinburgh*, 1846.

J. C. Prichard: Physical History of Man, Vol. v, 8vo. *London*. 18*s. cl.*

C. Lyell: Principles of Geology, 7th edit., 1 vol., 8vo. *London*, 1847. 18*s.*

Richard Owen, F.R.S.: Lectures on Comparative Anatomy and Physiology of the Vertebrate Animals. Part I, Fishes; being Vol. ii, of Hunterian Lectures. *London*, 1846.

G. Bischof: Lehrbuch der chemischen und physikalischen Geologie. 1. Bds. 1 Abth. gr. 8. *Bonn*, 1846.

Dr. G. A. W. Herrich-Schäffer: Systematische Bearbeitung der Schmetterlinge von Europa, als Text, Revision und Supplement zu J. Hübner's Sammlung Europäischer Schmetterlinge. 1 Bd.; Die Tagschmetterlinge. Mit 75 illum. Kupfert. gr. 4. *Regensburg*, 1846.

Ph. F. v. Siebold: Fauna Japonica—Pisces: elaborant C. J. Temminck et H. Schlegel. Decas xi, fol. *Lugduni-Batav.* 1846. 8½*rxthl.*

Susemihl: Vögel Europa's, 29 Lief. gr. Lex. 8. *Darmstadt.* 1½*rxthl.*

Dr. J. J. v. Tschudi: Fauna Peruana, viii Lief. (Vögel.) Imp. 4., 2½*rxthl.*

F. Dozy et J. H. Molkenboer: Musci frondosi Archipelagi Indici, Fasc. ii. Imp. 4., 3½ Bog. *Lugduni-Batav.* 3½*rxthl.*

Lerebours and Secretain: Traité de Photographie, 5th edit., 8vo. 1846.

Proceedings of the Academy of Natural Sciences of Philadelphia, iii, No. 6, Nov. and Dec., 1846.—Fossil footprints of the Connecticut valley; *C. P. Wickersham*, p. 119.—New genera and species of Insects, (Brachycopris, n. g., having for its type the Copris carolina, Prionus fissicornis, Sphenostethus, n. g. allied to Prionus, Molorchus tenuipes, Enoplium venustum, Heterodromia, n. g., fam. Donaciadæ, Trogus nubilipennis, Ibalia maculipennis;) *S. S. Haldeman*, p. 124.—On the Cicada septendecim; *Miss Morris*, p. 132.—On the situation of the olfactory sense in the terrestrial tribe of the Gasteropodous Molluscs; J. Leidy,* p. 136.—On an instinct probably possessed by the Herons; *J. Cassin*, p. 137.

Proceedings of the Boston Soc. Nat. History, October, November, December, 1846.—Shells of the Exploring Expedition; *A. A. Gould.*†—Centrarchus fasciatus and C. obscurus of DeKay, identical with Huro nigricans of Cuvier; *L. Agassiz*, p. 184.—Shovel fish of Ohio; *Dr. Cabot*, p. 184.—Moose and Carabou, and American Raven, not identical with European species; *L. Agassiz*,‡ p. 187.—Pyranga roseo-gularis; Dr. *Cabot.*§ p. 187.—Echinus from the millstone grit of Georgia, Pygorhynchus Gouldii; *M. Bouvé*,‖ p. 192.

* This Journal, p. 434. † Ibid, p. 151, 311. ‡ Ibid, p. 436. ‖ Ibid, p. 436.
§ Ibid, p. 437.

Annals and Magazine of Natural History, Jan. 1847, No. 122.—Organization of the Polygastric Infusoria; *C. Eckhard.*—Three new species of British Coleoptera; *T. V. Wollaston.*—Birds of Calcutta; *C. J. Sundevall.*—A new British Sponge; *Dr. Johnston.*—Zoolog. Soc., Oct. 13. New species of Brachiopoda and Marginella; *G. B. Sowerby.*—Entomol. Soc. New Grasshopper from N. S. Wales; *W. F. Evans.*—New Paussidæ from India; *J. O. Westwood.*—New Holland Cryptocephalidæ; *W. W. Saunders.*—Botan. Soc. of Edinburgh. Dr. Balfour on the Alpine Flora of the British Isles.

Jan. 1847. No. 123.—Formation of the Flints of the Upper Chalk; *J. Toulmin Smith.*—British Rubi; *C. C. Babington.*—On a peculiar organ in the Rays; *C. Robin.*—An Ichthyolite from Sheppey; *R. Owen.*—Development of the Lycopodiaceæ; *K. Müller.*—Drafts for a Fauna Indica; *E. Blyth.*—Habits of the Limpet; *G. Roberts.*—Entomolog. Soc. New Holland Cryptocephalidæ; *W. W. Saunders.*—Two new Goliath Beetles, and some new Scutelleridæ; *J. O. Westwood.*—Insects from Cape Palmas; *Dr. Savage.*

Feb. 1847. No. 124.—New species of Gynautocera from N. India; *E. Doubleday.*—Ornithology of the Island of Tobago; *Sir Wm. Jardine.*—British Rubi; *C. C. Babington.*—Birds of Calcutta; *C. J. Sundevall.*—New species of Actias from N. India; *E. Doubleday.*—New or rare British Animals; *R. M'Andrew* and *E. Forbes.*—Drafts for a Fauna Indica; *E. Blyth.*—Development of the Lycopodiaceæ; *K. Müller.*—Outline of an Arrangement of Stony Corals; *J. E. Gray.*—Zool. Soc. Birds from Malacca; *Mr. Strickland.*—Three Australian Birds; *Mr. Gould.*—Microscop. Soc. On the Intimate Structure of Bone; *Mr. Quekett.*

March, 1847. No. 125.—Reproduction of lost parts in the Articulata; *G. Newport.*—Notes on Buccinum undatum; *A. Hancock.*—On a second form of fructification in Peyssonelia squamaria; *C. Montagne.*—New species of Atya; *G. Newport.*—Birds of Calcutta; *C. J. Sundevall.*—New Lepidoptera; *E. Doubleday.*—On the Irish species of Cephaloptera; *F. M'Coy.*—Drafts for a Fauna Indica; *E. Blyth.*—Linnæan Soc. Notes on the Fauna of N. Zealand and the Aucklands; *A. White.*—On the calcifying functions of the Cowrey and Olive; *L. Reeve.*—Structure and Movements of Bacillaria paradoxa; *G. H. K. Thwaites.*

London Journal of Botany, for *January*, 1847.—Sur le genre Godoya, etc.; *Dr. Planchon.*—Botanical Information, viz: Thorea ramosissima, found in the Thames.—Account of Gutta Percha, a new vegetable production lately used in the arts as a substitute for Caoutchouc, &c. shown to be yielded by a Sapotaceous plant.—Bourgeau's Canary Island Plants.—Proposed Nat. Hist. Journey to Bosnia.—Mitchell's Expedition in the interior of New Holland.—Letter from Mr. Gardner on the Botany of Ceylon.—Notes of a Continental Tour, continued, (Moscow to Constantinople and Florence.)—Review of Gardner's Travels in Brazil.—February, 1847.—Notices of Lindley's "Orchidaceæ Lindenianæ;" of *Martins*, "Voyage Botanique le long des Côtes Septentr. de la Norvège;" of *Gardner*, "On the structure and affinities of Podostemaceæ;" of *C. H. Schultz*, on Hypochærideæ; of *Parlatore's* "Flora Palermitana" and "Monogr. delle Fumariee;" of the "Genera Pl. Floræ Germanicæ," continued by *Putterlich* and *Endlicher*, (up to fasc. 24); of *Miers*, "Illustrations of S. American Plants," part 1; of *Gray's* "Chloris Boreali-Americana;" *Sullivant's* Musci Alleghanienses and "Contributions to the Bryology and Hepaticology of North America."—Catalogue of Mr. *Geyers'* Upper Missouri and Oregon Collection of Plants, up to Rhamneæ inclusive.—Journal of the Voyage to the Niger; *Dr. Vogel*—continued.—"Floræ Tasmaniæ Spicilegium;" *Dr. J. D. Hooker*—continued.

Comptes Rendus, Paris. Nov. 23.—Chemical Researches on Dyeing; *Chevreul.*—On the application of the new formula of interpolation to the determination of the orbits described by celestial bodies, and on the direct introduction of observed longitudes and latitudes in Astronomical formulas; *A. Cauchy.*—On the isolation of Fluorine, and composition of Fluorides; *Louyet*—On Gun-cotton; *Gaudin, Fordos* and *A. Gélis, Becker, Dumas.*—Nov. 30. On the Potato Disease; *Payen.*—On the alteration of Beet-sugar; *Payen.*—Gun-cotton; *Payen, Piobert, Pelouze, Morel.*—On the introduction of phosphate of lime into organic beings; *Dumas.*—Relation between the nitrification and fertilization of land; *Kuhlmann.*—Dec. 7. Potato and Beet Disease; *Gaudichaud.*—On the Silicates; *Laurent.*—On Fluorine; *Quet* and *Colin.*—On Gun-cotton in blasting; *Combes* and *Flandin.*—Explosion of Gun-cotton; *Figuier* and *Poumarède.*—Application of Gun-cotton to Machinery; *Riotte.*—Dec. 14. On the maxima of effects of the explosion of Gun-cotton; *Payen.*—On different substances called Gun-cotton; *Gaudichaud.*—On Metallic Polarization; *Jamin.*—Dec. 21. On Hydrates; *Fremy.*—On pyroxyline; *Vankercknoff.*

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